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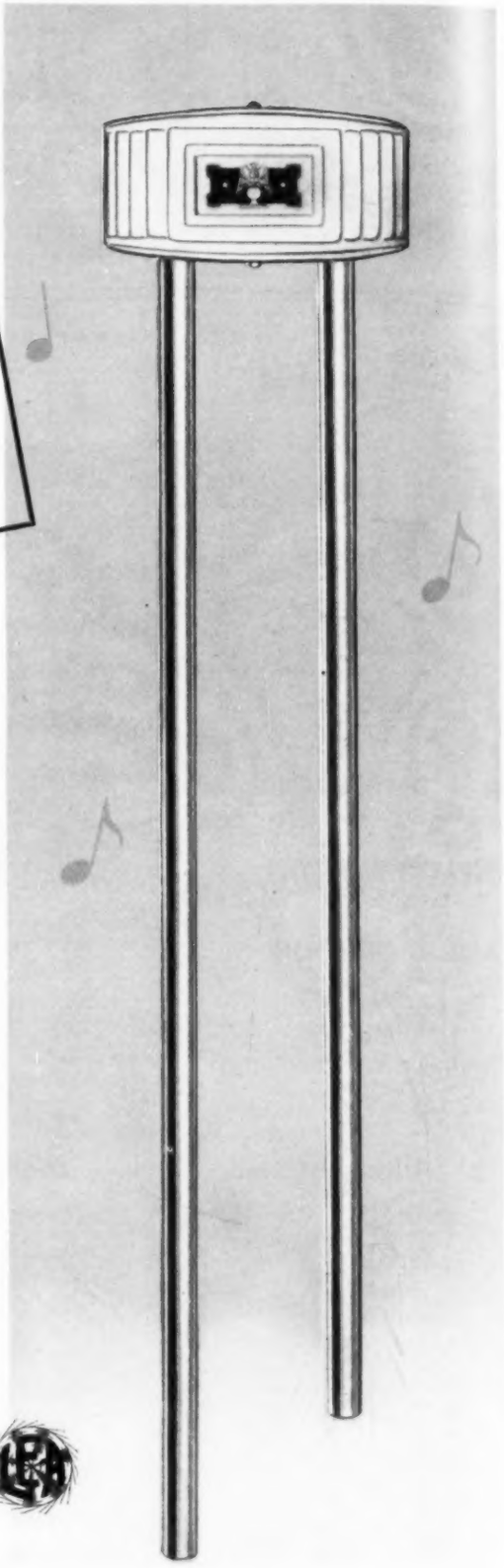

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METAL INDUSTRY
FABRICATION · ASSEMBLING · PLATING · FINISHING
VOL. 37, NO. 9 SEPTEMBER, 1939

The Commercial Development of Organic Chemicals

THE production, on a large commercial basis, of hundreds of organic chemicals, which a short few years ago were curiosities of the laboratory, is astonishing.

The commercial production of the glycol derivatives has given us an excellent radiator anti-freeze in inhibited ethylene glycol, non-edible glycerine substitutes in diethylene glycol and its derivatives, lacquer solvents in the ethyl and butyl ethers, chlor-hydrins for further synthesis and for inducing pre-mature germination of potatoes.

Organic sulfonates, sulfates and ethers are being produced with excellent wetting power, are stable in acid or alkali, and are not precipitated by hard water. They are being used as anti-pitting agents in nickel plating solutions and as detergent aids in alkaline cleaners.

The hydrocarbon solvents have been augmented by hydrogenated naphthas, cyclohexane, and hydrogenated naphthalenes which possess high solvencies for gums and resins approaching those of the coal-tar hydrocarbons such as tolene and xylene.

Butyl alcohol is being produced commercially by both organic fermentation and synthesis and is finding wide use in lacquer thinner formulation. Normal and iso alcohols are available with wide physical and chemical properties and new ketones such as methyl-ethyl ketone and phorone augment acetone.

Probably the most amazing developments have been in the field of synthetic resins and their application to plastic molding and to baking enamels. This field includes phenol-formaldehyde, glycerol-phthalic anhydride, urea-formaldehyde and vinyl chloride condensation products. Only ten years ago, synthetic enamels were in their infancy, but today even in their adolescent period, they have attained wide acceptance in industry—on automobiles, radios, washing machines and wherever high coverage, tough, adherent, corrosion resistant films are desired..

The achievements of American industry in both the production and utilization of new organic compounds have been as a result of the impetus given to their study by our deficiencies during the world war. The effects of these new developments are far reaching, varying from new destroyers of streptococci to addition agents in bright nickel plating solutions. The future of the organic chemicals industry is bright and promises to contribute even more towards an abundant life.

Safety Precautions for the Use of Compressed Air

The plating and finishing industries use compressed air extensively for drying of parts, sand blasting, blowing off sawdust or for spraying of organic finishes. Careless or improper use of compressed air may result in serious injuries, particularly eye injuries.

If we jump off a dock into water it would be into relatively soft water, but if we jumped out of a moving airplane into water, it would feel as hard as concrete. Similarly, the dust particles which may be wafted into our eyes by the breeze may be merely annoying, but if compressed air is blown at our eyes, they are given a terrific bombardment of particles which may cause blindness.

The momentum of a moving object increases linearly with the weight but as the square of the velocity. Thus, if the velocity of a particle is doubled, it is equivalent to increasing the weight fourfold and if the velocity is trebled, it is equivalent in momentum to being hit with a particle nine times heavier.

Because it is dangerous, compressed air should be touched only by authorized people. Cleaning dust off clothing and hair, or cooling the body with it will be likely to make anyone blind or deaf sooner or later. Trying to put air inside the body of someone else as a joke may cause fatal injury. Workers who are allowed to work with compressed air should wear goggles or other eye protection if needed, and should be sure to think about the safety of those nearby.

A flexible compressed air hose should be made from good material and inspected often for wear or defects which might cause a rupture. If a hose does break while a worker has his face near it, the air rushing out may injure his eyes. If repairs are to be made, it is a poor idea to attempt them when the air is on; for safe repairs the air should be shut off. To keep hose safe, it is necessary to place it where it won't be rubbed against by equipment or run over by shop trucks.

Hoses in aisles and passageways and on stairs are tripping hazards, which a little care in placing the hose will avoid. Sometimes the hose can be strung out of the way. The power of compressed air is shown when a carelessly made hose connection breaks; often the hose will whip around with great speed and a metal connection, if it hits a worker on the head, can give him a serious head injury.

Compressed air should, therefore, be handled with care and respect for its potential hazards.

Anomalous Corrosion of Some Hot-Galvanized Coatings

During recent years, difficulty has been experienced with rapid pitting of hot-galvanized sheet exposed to the atmosphere. Severe pitting of hot-galvanized water troughs has occurred in one year of exposure.

Recent studies have shown that hot-galvanized coatings which are prone to rapid pitting (1-3 years) contain relatively high tin contents (0.5% to 1.25%), and sheets which have satisfactorily withstood long-time atmospheric exposures (15-30 years), have relatively low tin contents (0.02-0.30%).

The type of pitting in the zinc coatings changes from broad shallow pits with low tin contents to small, deep, numerous pits in the zinc coatings with high tin contents. The accelerating effect of tin on the corrosion of zinc has been explained as follows: The tin, divorced from the tin-zinc eutectic, forms a substantially pure film around the zinc crystals and as corrosion proceeds, the tin is reprecipitated with the coincident solution of an equivalent amount of zinc. The tin will also form a couple with the iron-zinc alloys thus accelerating local corrosion.

Further study is required to fully evaluate the effects of tin on hot galvanized coatings, but the data now available indicate that a high tin content may be responsible for many of the puzzling cases of rapid, deep pitting observed in sheet in contact with water either intermittently or continuously.

The anomalous, rapid corrosion of galvanized steel pipe used for hot water lines has been extremely troublesome in high pressure hot water systems where the temperature is above 140°F. Schikorr has shown that under the conditions for rapid corrosion of the pipe, the zinc coating changes its polarity in respect to the iron pipe and therefore becomes cathodic. The pipe, on becoming anodic, undergoes rapid corrosion with subsequent perforation and failure often within less than a year.

Bright Dipping of Non-Ferrous Metals*

By Dr. Walter R. Meyer

Editor, Metal Industry

The latest developments in bright dipping of non-ferrous metals are described. Sulfuric-nitric acid and chromic acid dips are discussed. Bright dipping of aluminum, zinc, cadmium, copper and their alloys is described. Anodic brightening of nickel and anodic "smoothing" of copper are considered.

Introduction

Bright dipping may be done for several reasons: namely, (1) To produce a bright finish to be used as such, (2) To remove oxides, scale or dirt, (3) To prepare the basis metal for plating, (4) To remove contaminating or stain-inducing chemicals, and (5) To "polish" or smooth the surface where mechanical methods are not practical or possible.

The pre-requisites of a good bright dip are:

(1) Rapid attack on scale and oxides. This requisite has prevented the use of many bright dips which readily attack the basis metal but do not remove scale. Thus, a chromic acid bright dip for copper or its alloys is only satisfactory for bright dipping when the parts are not covered with black cupric oxide.

(2) The dip should be controllable. The chief disadvantage of the sulfuric acid-nitric acid bright dips is their rapid attack on the metal being dipped thus necessitating rapid removal of the work resulting in high acid losses. A 1:1 sulfuric-nitric acid dip at 25°C removes 1.5 gm. per sq. ft. per min. whereas the dichromatic dip removes 0.6 gm. and a 20% ferric sulfate dip, 0.25 gms. per sq. ft. per min.

(3) The products of reaction should be readily rinsable and should induce no residual staining. A fault of chromic acid dips is the poor rinsing quality of chromic acid per se and of tri-valent chromium salts. A thin deposit of chromium salts left on zinc may induce very rapid discoloration causing the zinc to turn blue or black.

(4) The dip should attack uniformly all constituents of the alloy being dipped. The failure to meet this requisite will result in a smut being formed from the residual undissolved material. Thus alkaline etching of aluminum leaves a film of silicon, copper and iron, and dilute nitric acid may brighten pure zinc, but will darken zinc alloys due to residual copper.

(5) The bright dip should give a contrast etch.

*This paper was presented at the annual convention of the American Electroplaters' Society held at Asbury Park, N. J., June 19-22.

Mechanism of Bright Dipping

The brightening action of a bright dip is due to the chemical removal of oxide, etc., with a subsequent contrast etch which involves the removal of layers of atoms from the faces of the crystals or grains developing the facets (often submicroscopic) which act as reflecting surfaces resulting in brilliance. This mechanism is borne out by the fact that most bright dips are oxidizing in character.

Figure 1. Deep contrast etching of copper with an oxidizing bright dip.

Failure of a dip to produce brightness may be due to primary attack on the grain boundaries where usually the impurities are more highly concentrated, pit attack on the face of the crystals, or over-contrast etching. A small amount of chloride, for example, added to a sulfuric-nitric acid dip will cause a marked increase in the brightening action on copper or its alloys due to the generation of nascent chlorine or in effect oxygen, which induces ready solubility of the faces of the grains resulting in uniform contrast etching.

Bright Dipping of Metals

Aluminum Alloys

The so-called bright dipping of aluminum is not entirely bright dipping in the sense of the previous discussion, but rather is a pronounced etching process which greatly increases the effective area of the surface, which is bright due to the whiteness and high reflectivity of the metal.

High purity aluminum, such as 2S is etched in alkaline solutions with the formation of sodium aluminate and

Figure II. High magnification of a copper crystal showing etching facets.

hydrogen, the latter helping to mechanically remove organic dirt.

A 4 oz. per gallon solution of trisodium phosphate operated near the boiling point produces a fine uniform white etch and is more easily controlled than caustic soda. The film of metallic impurities may be removed by a dip in strong nitric acid (1:1 to con. acid). The longer the etching time, the greater the amount of smut because it is formed by preferential solution. Strong nitric acid is preferred because the aluminum is passive in strong acid but not in dilute acid.

Aluminum alloys containing large amounts of silicon, copper and iron require a mixture of nitric and hydrofluoric acids, such as:

Nitric acid (Sp.Gr. 1:42)	3 vol.
Hydrofluoric acid (48-52%)	1 vol.

Room Temperature

The hydrofluoric acid etches the aluminum and dissolves the surface silicon; the nitric acid removes the copper and a bright etch is secured. This dip requires special tanks of wax-coated lead. However, several organic linings have recently been claimed to resist these acids.

Zinc and Cadmium

Pure sheet zinc, electroplated zinc and cadmium may be bright dipped in dilute nitric acid (½-1% by vol.); with mineral acids plus oxidizing agents such as sulfuric acid and hydrogen peroxide; and with chromic acid-sulfate solutions. The last-named solutions produce particularly brilliant finishes especially if the zinc is contaminated with foreign metallic impurities such as copper. It may also be used for dipping zinc alloys. A typical chromic acid dip is as follows:

Chromic acid	35 oz./gal.
Sodium sulfate or equivalent other sulfates	2 oz./gal

The sulfate radical is essential for proper results probably due to the solubilizing of the trivalent chromium salts which form due to the reduction of hexivalent chromium to trivalent chromium when reacting with the zinc.

Concentrations of chromic acid below 30 oz./gal. are prone to more rapid formation of poorly rinsable yellow films.

The work may be dipped in a dilute sulfuric acid solution (½-1% by volume) to remove any yellow film which may remain after rinsing the work subsequent to the chromic acid dipping.

The greater brilliance of the finish from the chromic acid dips in comparison with the nitric acid or sulfuric acid dips, is due to the pronounced clean contrast etching of the crystal faces in the chromic acid solution as against the relatively plain etching and pitting in the nitric acid dip. Many of the dips for zinc and cadmium are covered by patents owned by the Hanson-Van Winkle-Munning Co., The Udylite Corp., (Soderberg), The DuPont Co., (Hull), and The General Electric Co. (Meyer & Dunleavey).

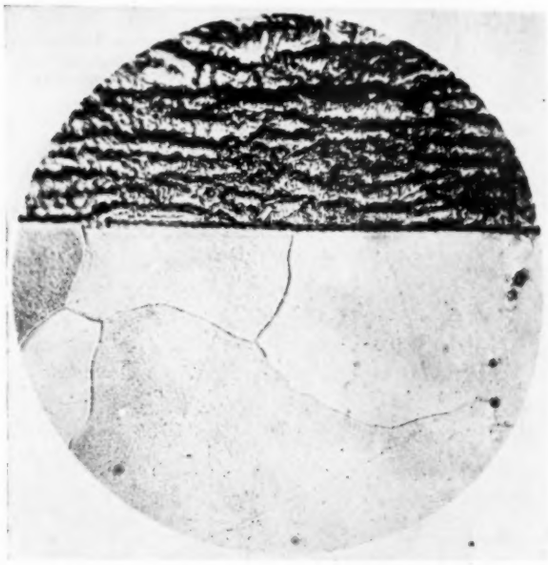

Figure III. Electroplated zinc (top) and cast zinc (bottom) etched with a chromic acid etch.

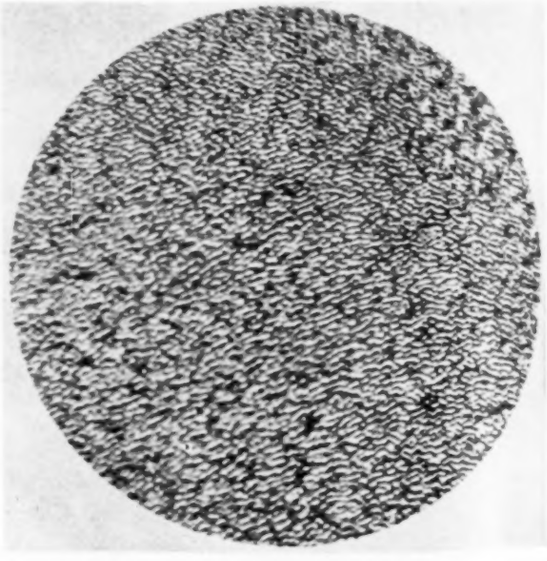

Figure IV. High magnification of cast crystal in Figure III showing etching facets.

Nickel

A brilliant finish comparable to buffing may be produced electrolytically on nickel plate or sheet nickel by making the work the anode in a sulfuric acid solution. (U. S. Patent No. 2,145,518). The conditions are as follows:

	Optimum	Range
Sulfuric acid	55°Be (70%)	45°-62°
Temperature	100°-125°	85°-140°F.
Current density	——	280-560 amps./ft.^{2}
Voltage	——	8-10 volts
Time	——	10-25 seconds

Anodic etching is particularly valuable for polishing irregularly shaped articles and it obviates the danger of cutting through on edges which is attendant with wheel buffing.

The high current density requires tight, high conductivity racking similar to that for chromium plating. The brightening action is a result of a contrast etching due to the formation of a large amount of nascent oxygen in the presence of sulfuric acid. There is probably also a smoothing action due to protection of the recesses by undiffused salts and the dissolving of minute projecting surfaces.

Figure V. Rolled zinc dipped in a chromic acid solution.

Copper and Copper Alloys

The usual sulfuric-nitric acid bright dips have been described in previous papers but certain aspects will be considered at this time. A typical formula is as follows:

Sulfuric acid (con.)	2 gal.
Nitric acid (con.)	1 "
Water	1 quart
Hydrochloric acid or salt	¼ to ½ oz.

Increased reactance results from increasing the ratio of nitric to sulfuric acid and by adding water. It is frequently observed that fresh dips will work more effectively if a small amount of spent dip is added. This is probably due to the presence of nitrous acid in the spent dip which greatly catalyzes the rate of reaction of nitric acid with copper. An increase from 0.1% to 0.5% in the nitrous acid content of nitric acid will increase the rate of reaction almost 400%.

The beneficial effects of soot or carbon treatment are probably due to the removal by adsorption of lower nitrogen oxides and of chlorine when salt or hydrochloric acid is added in excess.

Two chief difficulties of the sulfuric-nitric acid bright dips are: (1) their high rate of reaction which necessitates rapid removal of the work resulting in high drag-out losses, and (2) the corrosive fumes of nitrogen dioxide which are dangerous physiologically and are particularly corrosive.

The writer has studied the effects of numerous oxidizing agents in conjunction with the sulfuric-nitric acid dips in the hope of reducing the reactivity and fume evolution.

The work has shown that chromic acid will decrease gas evolution and in most cases, practically eliminate it. Dilution of the solution, when chromic acid is added, also decreases gas evolution. HCl is necessary for satisfactory dipping.

From the data recorded, the range for bright dipping appears to be as follows:

H_2SO_4	80 cc.	H_2SO_4	65 cc.
HNO_3	20 cc.	HNO_3	35 cc.
H_2O	100-200 cc.	H_2O	100-150 cc.
CrO_3	20-100 g.	CrO_3	10-20 g.
HCl	1 cc.	HCl	1 cc.

Further dilution of the 65-35 series caused slight film formation on shells. Further increase of HNO_3 and decrease of H_2SO_4 gave unsatisfactory plates. Most of the shells dipped in solutions outside of this range became covered with a thin film.

Best dips were obtained from solutions of the HNO_3-20, H_2SO_4-80 series where CrO_3 up to 55 or 60 grams, and water to 200 cc. had been added. A solution of this range gave excellent finishes and no noticeable gas was evolved.

The relatively large amount of water is necessary to dissolve the chromic acid. The chloride is required for a bright finish. Dips of this type evolve practically no fumes of nitric oxide, and in some cases, have been used in open rooms without exhausting, with no discomfort to the workmen. Because of the lower rate of reaction, longer draining time could be used and decreases in drag-out resulted in considerable saving. Unfortunately, these dips do not produce as uniform an etch over large surfaces of metal as do the conventional types, and hence their use has been limited to small objects. They are also unsatisfactory for dipping nickel silvers.

Anodic Polishing

Brilliant surfaces can be produced on copper which has been previously polished with at least 0000 emery paper, by making the copper the anode in solutions of orthophosphoric acid ranging in concentrations from 500 to 800 g/L, and using current densities between 60 and 100 amperes per sq. ft. The vertical surfaces require higher current densities than horizontal surfaces, due probably to the greater ease with which the film adjacent to the surface flows off the vertical surface. The remarkable brightening action which is obtained is called "anodic smoothing", and is probably due to a mechanism in which the salts accumulate in the minute recesses, and the higher points on the surface are corroded away until a perfectly plane surface is obtained.

P. Jacquet in France has done much in the development of anodic polishing, and this technique using perchlorates and other solutions, has been applied to polishing of other metals, such as lead. The surfaces produced by anodic smoothing have higher reflectivities than copper surfaces produced by buffing—probably due to the absence of oxides and organic matter.

The Formula and Analysis of the Cadmium Cyanide Complex

By Nathaniel Hall

Due to some uncertainty in the literature, the author determined the formula of the cadmium cyanide-sodium cyanide complex by allowing long time contacts. The equilibrium ratio was found to be 1 mol of CdO to 3.8 mols of NaCN thus indicating that the factor 1.74 is sufficiently accurate for calculating combined NaCN from the metallic cadmium content.

The author also shows that the presence of ammonia (resulting from the decomposition of the sodium cyanide) will affect the accuracy of the determination of free sodium cyanide and high results will be obtained by titration with silver nitrate in the presence of ammonia. A method for determining total sodium cyanide by titrating with silver nitrate after the addition of ammonia is described.—Ed.

Introduction

When the subject of the correctness of the formula of a plating compound is brought up, the first argument in favor of the status quo is that comparative figures are not affected by errors in the formula. If the figures used in computing the free cyanide content of a cadmium solution are erroneous, the operation of the solution is not affected if the same figures and analytical procedure are employed day after day and give reproducible results.

This is obviously true, but even if we neglect the satisfaction which comes from the thought of doing things rightly and the philosophical desire to solve a problem merely to contribute something to the store of scientific information, and concern ourselves only with the practical aspects of solution maintenance, we can still see a need for a correct formula for the cyanide complex of cadmium.

Maintaining a cadmium solution by comparative analytical results may be practical, but it involves the uneconomic method of trial and error with its accompanying waste of time and chemicals. If we find upon analysis that cadmium oxide must be added to the solution, how much cyanide is necessary to dissolve it? By adding an excess of sodium cyanide, we increase the free cyanide content of the solution beyond the desired concentration. If we add too little, the difference is made up at the expense of the free cyanide, thus necessitating another analysis and further additions of cyanide all of which involve time and money.

Nathaniel Hall

In the case of a commercial laboratory which analyzes plating solutions for plating rooms without such facilities, trial and error are out of the question. If the free cyanide is to be determined, it must not be the comparative value, but the actual value in order to eliminate the possibility of error due to difference in method of analysis. The client must be told how much metal and how much cyanide he requires to bring his solution up to the desired values. It should not be necessary for him to send another sample to the laboratory after making these additions, in order to determine whether the correct amounts of materials were recommended in the first place.

Formula of the Cadmium Cyanide —Sodium Cyanide Complex

These considerations led to a series of experiments with cadmium solutions for the purpose of establishing an analytical procedure which would give reproducible results, not in any one solution but in different types of solutions. The first step was to verify the formula of the cadmium cyanide complex which is an important constituent of the solution.

Literature on the subject revealed experimental results which indicated formulae containing from 3 to 4 mols of cyanide to each mol of cadmium. These were obtained by determining pH changes and conductance changes[1], polarographic measurements of deposition potentials[2], potentiometric titrations[3] and other methods, all involving the reaction between cadmium salts and cyanides. For our tests, a solution of sodium cyanide was added to an excess of pure cadmium oxide.

Since, according to the law of mass action, the rate of reaction is a function of concentration, we would expect the rate of reaction to slow

down as the amount of uncombined cyanide decreases. In order to allow the reaction sufficient time for completion or at least for the components of the mixture to arrive at the final equilibrium state, it was decided to figure on about half a year, the mixture being shaken up every few days during this period. At various times the supernatent liquid which under ideal conditions should contain practically no free cyanide was filtered and the filtrate was analyzed for metal and total cyanide. The results are tabulated in Table 1.

TABLE 1

	Period of Reaction		
	24 days	48 days	140 days
1. Total sodium cyanide in grams	0.118	0.121	0.121
2. Metallic cadmium in grams	0.0694	0.0724	0.0738
3. Combined cyanide as NaCN in grams according to formula $NaCd(CN)_3$	0.0914	0.0948	0.0990
4. Free cyanide as NaCN in grams according to 1, 2 and 3 above	+0.0223	+0.0257	+0.0241
5. Combined cyanide as NaCN in grams according to formula $Na_2Cd(CN)_4$	0.1213	0.1260	0.1283
6. Free cyanide as NaCN in grams according to 1, 2 and 5 above	—0.0076	—0.0055	—0.0075
7. Ratio NaCN:CdO by weight	1.53	1.45	1.43
8. Mol ratio—NaCN:CdO	3.7	3.8	3.8

The results show that the solution contained 3.8 mols of cyanide for each mol of cadmium which would indicate the formula $Na_{1.8}Cd(CN)_{3.8}$ or possibly a mixture of both $NaCd(CN)_3$ and $Na_2Cd(CN)_4$ in the ratio of about 20% and 80% respectively. These experimental results agree very closely with Wernick's[5] value of 3.8 and Maclachlan's[4] values of 3.7 and 3.8. For practical purposes a mol ratio of 4.0 should be entirely satisfactory, therefore, which in calculating combined cyanide as sodium cyanide requires that the metallic cadmium as determined by analysis be multiplied by the factor 1.74.

The analysis of the solution for metallic cadmium does not present any unusual difficulties. Precipitation as the sulfide and titration with standard potassium ferrocyanide gives sufficiently accurate results. If copper or iron is known to be present, the washing of the cadmium sulfide precipitate should be carefully performed in order to prevent occlusion of the plating solution and titration of the copper and iron together with the cadmium.

The Cyanide Analysis

The analysis of the cadmium solution for the cyanide content was another subject which was considered of considerable importance. There are certain important advantages in determining free cyanide directly by analysis rather than indirectly by calculation from the metal and total cyanide values. There is a saving in time required for titration and calculation and less standard silver nitrate solution is necessary. Also the solution can be analyzed for free cyanide in a very short time without determining the metal content, which in cyanide solutions, is always a much more involved procedure.

When silver nitrate is added to a cyanide solution, it combines with the free cyanide according to the following equation:

$$AgNO_3 + 2NaCN = NaAg(CN)_2 + NaNO_3$$

As soon as all the free cyanide has combined, additional silver nitrate combines with the sodium metal cyanide and begins to precipitate as the simple metal cyanide as follows:

$$AgNO_3 + NaAg(CN)_2 = 2AgCN + NaNO_3$$

Since this type of end-point has been found to be indistinct, potassium iodide is used as an indicator, in which case the additional silver nitrate reacts with the potassium iodide preferentially to form a precipitate of silver iodide as follows:

$$AgNO_3 + KI = AgI + KNO_3$$

This procedure for the determination of free cyanide is generally used for all cyanide solutions and has been recommended by Meyer and Daniels[6] for use in cadmium solution analyses.

In commercial laboratory practice, however, the results obtained by this method are not sufficiently reproducible to permit of its use in determining the free cyanide contents of cadmium solutions.

Because of the very high cyanide content, there is some decomposition resulting in the formation of sodium carbonate and ammonia, the reaction being represented as follows[7]:

$$2NaCN + 2H_2O + 2NaOH + O_2 = 2Na_2CO_3 + 2NH_3$$

In the presence of ammonia, the end-point does not occur when all the free cyanide has been titrated. This is probably due to the formation of the soluble cadmium ammonia complex which may be represented by the reversible reaction:

$$Na_2Cd(CN)_4 + 4NH_3 \rightleftarrows Cd(NH_3)_4(CN)_2 + 2NaCN$$

some of the combined cyanide being liberated and titrated as free cyanide, thus giving high results.

Determinations made on a typical cadmium plating solution received for analysis from a local plater gave the following results:

TABLE II

Constituent	Oz./gal.
1. Metallic cadmium	2.60
2. Total cyanide as NaCN	10.5
3. Combined cyanide as NaCN (1.74 x metal)	4.5
4. Free cyanide as NaCN—calculated	6.0
5. Free cyanide as NaCN—titrated	8.4
	(No NH_4OH added)

The odor of ammonia in this solution was readily noticeable. The error which would result in titrating such a solution for free cyanide is 40%. When no ammonia is pres-

ent, there is no doubt but that the figure for free cyanide is accurate and is verified by Trial 1 in Table III.

Since solutions from various sources contain varying amounts of ammonia, the safest procedure is to add sufficient ammonia to keep all the metal in solution, in which case, the analysis will indicate the total cyanide.

The final series of experiments were made with the view of determining the most suitable procedure for the analysis of total cyanide. Samples of cadmium solution containing 3.22 oz./gal. of total cyanide and 1.85 oz./gal. of metal were pipetted into 250 cc. Erlenmeyer flasks. One hundred cc's of distilled water were added to each, and also varying quantities of concentrated ammonia and potassium iodide. The solutions were titrated with standard N/10 silver nitrate, the appearance of turbidity indicating the end-point. The results are tabulated in Table III.

TABLE III

	Ammonia cc's	KI grams	NaCN present oz./gal.	NaCN found oz./gal.
1.	0.0	0.5	0.0 free	0.0 free
2.	Added 30 cc. to (1) above	0.5	3.22 total	3.27 total
3.	15	0.5	"	3.22 "
4.	15	0.5	"	3.22 "
5.	30	0.5	"	3.30 "
6.	30	0.5	"	3.27 "
7.	Added 20 cc. to (6) above	0.5	"	3.41 "
8.	15	2.0	"	3.06 "
9.	30	2.0	"	3.17 "
10.	30	2.0	"	3.17 "

The results indicate that 15 cc. of ammonia and 0.5 gms. of potassium iodide indicator in a total volume of about 125 cc. of solution give accurate results. Increasing the ammonia content results in higher values which is to be expected because of the tendency of the silver iodide precipitate to dissolve in higher concentrations of ammonia[8], while increasing the potassium iodide concentration gives lower values. It is interesting to note that these two factors may be used to balance each other.

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Routine Tests for Tinplate*

By W. E. Hoare, B. Sc.

A resume of the methods for determining the porosity of tinplate.—Ed.

The problem of measuring the service value of tinplate by routine tests has many difficulties. The significant factors influencing service value include mean thickness of coating, and variation about the mean, degree of continuity of the coating, characteristics of the steel base, and finally the service demanded of the tinplate.

To take the last consideration first, service value obviously depends on factors other than the tinplate itself. Recent work by Vaurio, Clark and Lueck[1] has shown that the corrosiveness of certain fruits varies from season to season and therefore the service value obtained will vary. Again, the packing of milk, meat or boot polish may result in quite different degrees of satisfaction in service, although the same quality of tinplate has been used. In consequence, the figure given by any routine test, conveniently termed by Gire[2] the "Coefficient of (Corrosion) Resistance" should have involved in its determination a knowledge of the use to which the material will be put.

The deviser of routine tests has therefore to examine the inter-relation of a number of variables and by determining the validity and extent of such relationships to evolve tests of reasonable simplicity that indicate the future service value of the tinplate.

The Porosity Test

Apart from a determination of the thickness of the tin coating, the traditional measure of quality is the porosity test. This aims at estimating the number of discontinuities in the tin layer, and provides a valuable index of quality. The technique of this test has been materially advanced by the Council's researches[3] but no more must be read into the results of tests than they will scientifically bear. Tests of this type measure only the degree of continuity of the coating and do not regard other qualities, however important, such as the properties of the base metal or the

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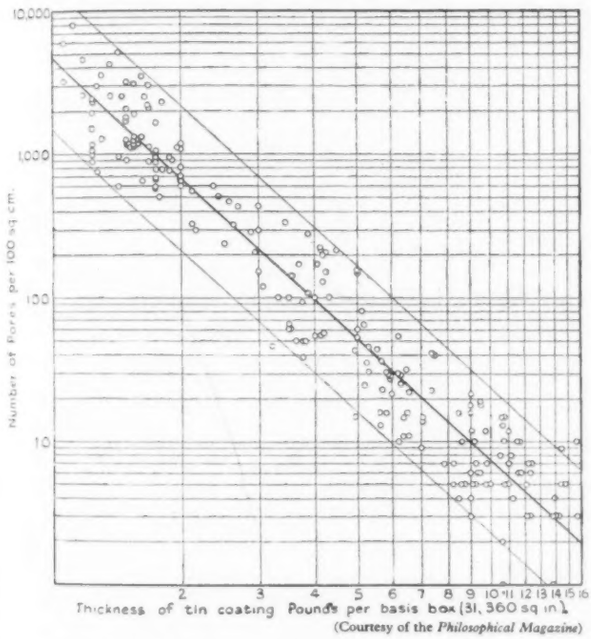
thickness of the tin coating (except insofar as the thickness affects porosity). Defects which are only potential pores are also not disclosed, although this may in part be overcome by submitting the specimens to a preliminary and controlled deformation.

Fig. 1 has been compiled from a large number of tests made by the Council[4] on tinplate taken from a wide variety of sources and shows the intimate relationship of the tin coating. Taggart[5] has derived a mathematical formula to express this relationship, and it has further been shown[6], by manipulation of the above results in the light of a theoretical investigation by the Council[7] on minimum permissible parameter of normal pore sites, that the area of steel basis exposed can be expressed in terms of the coating thickness and/or porosity.

The position is, therefore, that although the porosity test does not provide a rigid standard for general purposes, consumers may find certain working limits satis-



(Courtesy of the *Philosophical Magazine*)

Fig. 1. Relationship between the number of pores and the thickness of the tin coating.

factory for their particular needs, and where other tests have left doubt in the minds of inspectors, a good porosity test figure might be decisive.

The Acid Test

Another test has been devised by Morris.[8] Small quantities of sulphur dioxide in hydrochloric acid tend to concentrate attack on the exposed steel rather than on the tin coating. An $\frac{M}{200}$ (0.18 g/L) solution of hydrochloric acid containing 15 parts per million of sulphur dioxide was found suitable. Tested in this solution at 32° C. for 24 hours, the amount of iron dissolved is found to be closely proportional to the area of iron exposed. The effects of variations in the inherent corrosion resistance of the steel base are to some extent overcome by the presence of sulphur dioxide.

Electrolytic Sulphidizing

Gire[9] has found that the reaction between tinplate and sulphides may be used to measure the suitability of tinplate for the canning of sulphur-containing products such as certain vegetables and marine foods. A preferred method is to make the specimen of tinplate the anode in a $\frac{M}{20}$ to $\frac{M}{10}$ (2.8-5.6 g/L) solution of sodium hydrogen sulphide and to run the test for say 10 minutes. Gire also used acetic acid under controlled conditions and found that the ratio of iron to tin dissolved provides a useful coefficient of serviceability.

The Hydrogen Evolution Value

The worked carried out by Vaurio, Clark and Lueck[1] of the American Can Company has extended knowledge of this subject particularly in the case of fruit packing. In spite of improvements in materials and processes, packers still needed some simple test which would effectively eliminate the small proportion of material responsible for the appearance of hydrogen swells after short storage times. A method, finalized in 1932, has given satisfaction as a routine control test since that date.

The test has some similarity to that described by Morris and Bryan in Special Report No. 40 of the Food Investigation Board, where the reaction between tinplate and a solution of hydrochloric acid is measured by the amount of iron dissolved. In the American test the coefficient of resistance is described as the hydrogen evolution value and is the time in hours required to produce 5 cc. of hydrogen. An important feature of this test is that the specimen has first been deformed in a die which renders the test more discriminative than if carried out merely on flat specimens. The originators of this test point out that in spite of variations between individual tests, the method provides a fairly accurate measure of service value of batches of tinplate made from a uniform quality of steel, but certain alloy constituents of the steel base may affect the value of the tinplate (with certain fruits) without a corresponding effect on the hydrogen evolution value. A general relationship between the hydrogen evolution value and the coating thickness was, however, clearly established, which forges another link in the chain of correlations between the fundamental properties of the plate and its value in commerce.

These relationships may now be summarized. Porosity is related to tin coating thickness, which is in turn related to service value. Area of iron exposed is related to amount of iron taken up in acid solutions and to porosity. The electrolytic sulphidizing results and the coefficients of corrosion resistance are related to tin coating thickness and to experiences of the value of tinplate in various spheres of industry.

References

1. V. N. Vaurio, B. S. Clark and R. H. Lueck. Industrial and Engineering Chemistry, July 15, 1938. Anal. edn. **10**, pp. 368-374.
2. G. Gire. Rev. Trav. Office Peches Maritimes, 1936, **9**, pp. 421-436.
(*References concluded on page* 419)

Identification of Light Metal Alloys

By Edmund R. Thews

Consulting Metallurgist

The preceding discussion of the reaction of the four types of solutions used for the identification of aluminum alloys is of a descriptive nature unsuitable, as a whole, for the information or instruction of sorters. Table I given below should thus be prepared and handed to the sorters, etc. for their guidance.

This table shows the various spotting reactions induced by the four solutions on the magnesium and aluminum alloys arranged in their natural groups. It is frequently desirable, however, to make use of another arrangement based on the reactions obtained, i.e. chiefly on the reactions induced by the Solution No. 2. This latter arrangement is shown in Table No. 2.

TABLE 1

	Solution No. 1	2	3	4
Aluminum	....	White	....	....
Magnesium alloys	White	....	....	....
Aluminium-magnesium alloys	....	White	....	Gray
Aluminium-magnesium-silicon alloys	....	Grayish-Brown	Color removed	....
Aluminium-magnesium-manganese alloys	....	White	....	Gray
Aluminium-copper alloys	....	Black	Color remains	....
Aluminum-copper-nickel alloys	....	Black	Color remains	....
Aluminum-copper-zinc alloys	....	Black	Color removed	Gray
Aluminum-Silicon alloys	....	Grayish-Brown	Color remains	....
Aluminum-silicon-copper alloys	....	Gray	Color remains	....
Aluminum-silicon-magnesium alloys	....	Grayish-brown	Color remains	....

It will be noted on studying the two tables that there are no distinctive marks of difference between the aluminium-copper alloys and the aluminum-copper-nickel alloys, both groups yielding black spots with the Solution No. 2 which do not vanish

TABLE 2

	Solution No. 1	2	3	4
Magnesium alloys	White	....	....	....
Aluminum	....	White	....	....
Aluminum-magnesium alloys	....	White	....	Gray
Aluminum-magnesium-manganese alloys	....	White	....	Gray
Aluminum-copper alloys	....	Black	Color remains	....
Aluminum-copper-nickel alloys	....	Black	Color remains	....
Aluminum-copper-zinc alloys	....	Black	Color removed	Gray
Aluminum-silicon-copper alloys	....	Gray	Color remains	....
Aluminum-magnesium-silicon alloys	....	Grayish-brown	Color removed	....
Aluminum-silicon alloys	....	Grayish-brown	Color remains	....
Aluminum-silicon-magnesium alloys	....	Grayish-brown	Color remains	....

on application of Solution No. 3. The same applies to the aluminium silicon alloys and the related aluminum-silicon-magnesium alloys which yield grayish brown spots not removed by Solution No. 3. This difficulty is not very serious in both cases since mixing these alloys yields satisfactory ternary aluminum alloys of the respective compositions if melting, refining, alloying and ingotting is carried out with due care.

Average practical circumstances in smelting work and foundries are seldom such as to require the testing of every single piece of large scrap. In most cases, a lot of light metal scrap of fixed or approximate general composition is offered and it is necessary only to check the statements and specifications of the dealers, although it is important under all circum-

stances to consider the spot test a rough indication only and to check the results by a standard analysis as soon as possible. Small, but sometimes very deteriorating, impurities are not indicated by the spot test at all, but it is possible within the limits indicated above to effect a very neat classification of the light metal scrap.

It should be mentioned in this connection that intelligent application will soon indicate to the practical man, means and ways of refining the methods above outlined. For instance, it is possible after a comparatively short time of experience to estimate whether the copper contents of aluminum-copper alloys are large or small. If a drop of Solution No. 2 is placed on these alloys, a black spot is produced as shown in the tables. If, now, this spot is touched with a drop of Solution No. 3 (after wiping off the caustic alkali), the speed of elimination of this spot indicates the amount of copper present. The lower the copper content, the more rapid is the vanishing of the black spot, while if the spot remains for more than 10 minutes, an "American" alloy or an aluminum-copper-nickel alloy is indicated. If the black spot is removed at once, these aluminum-copper alloys contain zinc, while large amounts of zinc are indicated by the formation of a gray spongy deposit on the bright light metal surface after about 2 minutes of application. Smaller quantities of zinc (such as are present as lesser alloying constituents) do not give any etching effect with Solution No. 4 while intermediate percentages of zinc yield more or less pronounced gray etchings only. The time required to obtain a certain intensity of etching (gray) may also be indicative of the approximate amount of zinc present, if under the conditions involved, the results of these tests are compared with the results of chemical analysis for some time.

If it is desired to test an aluminum alloy for the presence of silicon, the Solution No. 2 will draw a spot of grayish-brown coloration if the amount of silicon exceeds 2 percent. The more rapid the coloration produced and the more intensive the final color, the larger are the percentages of silicon present. These differences are quite easily distinguished and intelligent men of experience have no difficulty in determining the approximate percentage of silicon in these alloys within ± 1 percent. If the silicon contents are very high, the spots will not vanish even under drops of the Solutions 1 or 3, while below 5 percent of nickel the coloration produced by Solution No. 2 vanishes more or less rapidly (according to the silicon contents). If these aluminum-silicon alloys contain copper, the spot produced by the Solution No. 2 gradually loses its brownish shade and becomes straight gray. These instances are indicative of the possibilities of the above method of identification. Investigations have been, and are still being made, to develop fresh indicators in addition to those already developed so as to enable the introduction of still more efficient and reliable modes of identification.

It may be of interest in this connection to dwell on the degrees of miscibility of the various groups of aluminum alloys with a view to their mutual influences. It is clear to every metallurgist and metal user that many of the alloys, or groups of alloys, now produced should not be mixed since their constituents develop more or less deteriorating influences if brought into alloying contact with those of other alloys, and it is very important to acquaint the sorter at least with the rudiments of this knowledge. Many years of experience laid down in numerous American, English, German and French publications brought out these alloying relations one by one, but they remained more or less of a great accumulation of facts until the scientist Dr. R. Irmann developed a diagram offering a clear indication of the limits of miscibility of the chief groups of alloys in question. This diagram is shown in Figure 1. The numbers on the left hand side and at top of the diagram denote the following alloys:—

(1) Aluminium-copper magnesium
(2) Aluminum-copper nickel
(3) Aluminum-copper
(4) Aluminum copper *castings*
(5) Aluminum-zinc-copper *castings*
(6) Aluminum-copper-nickel *castings*
(7) Aluminum-magnesium-silicon
(8) Aluminum-silicon
(9) Aluminum - magnesium - silicon *castings*
(10) Aluminum-silicon *castings*
(11) Aluminum-silicon-copper *castings*
(12) Aluminum - silicon - magnesium *castings*
(13) Aluminum-magnesium
(14) Aluminum - magnesium - manganese
(15) Aluminum-manganese
(16) Aluminum-magnesium *castings*
(17) Aluminum - magnesium - manganese *castings*

Diagrams of this type, with the three alternatives marked in different colors (preferably red, black and blue) and with the alloys indicated in full should be placed directly in front of the sorter's stand. Still better results are sometimes obtained if this diagram is combined with the information given in the Tables 1 and 2. Attention is called to the fact that it is advisable to collect the castings and forgings belonging to one group of alloys separately, for obvious reasons. The spot tests usually do not differ much between these products, but every sorter should be able to distinguish between light metal castings and forgings. It is true that the diagram, Fig. 1 does not indicate differences sufficiently pronounced to prohibit mixing of the castings and forgings of each individual group (See the aluminum-copper alloys Nos. 3 and 4, the aluminium-copper-nickel alloys Nos. 2 and 6, the aluminum-magnesium-silicon alloys Nos. 7 and 9 and the aluminum-magnesium alloys Nos. 13 and 16) but differences of composition exist nevertheless and separate ingots should be produced from each scrap wherever possible.

The diagram, Fig. 1, shows that only comparatively few groups of alloys are miscible in all proportions—which does not mean, of course, that the sorter must throw them together, since mixing of these various groups naturally depends on the composition of the ingots or, ultimately of the alloys to be produced. Still more pronounced is the need of care on the part of the sorter in the case of the groups of limited miscibility as he himself usually is not aware of the limitations in each and every instance. The diagram is of use to the sorter only in connection with special instructions from the manager or foreman.

LIGHT METALS ALLOYING DIAGRAM (IRMANN)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	G	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2	F	G	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
3	F	F	G	.	.	.	.	.	.	.	.	.	.	.	.	.	.
4	F	F	G	G	.	.	.	.	.	.	.	.	.	.	.	.	.
5	B	B	F	B	G	.	.	.	.	.	.	.	.	.	.	.	.
6	F	G	F	F	B	G	.	.	.	.	.	.	.	.	.	.	.
7	B	B	B	B	B	B	G	.	.	.	.	.	.	.	.	.	.
8	F	B	F	F	F	B	F	G	.	.	.	.	.	.	.	.	.
9	B	B	B	B	B	B	G	F	G	.	.	.	.	.	.	.	.
10	F	B	F	F	F	B	F	G	F	G	.	.	.	.	.	.	.
11	F	B	F	F	F	B	F	G	F	G	G	.	.	.	.	.	.
12	B	B	F	F	B	B	F	G	F	G	G	G	.	.	.	.	.
13	B	B	B	B	B	B	B	B	B	B	B	B	G	.	.	.	.
14	B	B	B	B	B	B	B	B	B	B	B	B	F	G	.	.	.
15	B	B	B	B	B	B	B	F	B	F	F	F	F	F	G	.	.
16	B	B	B	B	B	B	B	B	B	B	B	B	G	F	F	G	.
17	B	B	B	B	B	B	B	B	B	B	B	B	F	G	F*	F	G

G = Miscible in all proportions
F = Partly miscible
B = Should not be mixed

1. Al—Cu—Mg
2. Al—Cu—Ni
3. Al—Cu
4. Al—Cu castings
5. Al—Zn—Cu castings
6. Al—Cu—Ni castings
7. Al—Mg—Si
8. Al—Si
9. Al—Mg—Si castings
10. Al—Si castings
11. Al—Si—Cu castings
12. Al—Si—Mg castings
13. Al—Mg
14. Al—Mg—Mn
14. Al—Mn
16. Al—Mg castings
17. Al—Mg—Mn castings

Irmann's diagram indicates among a mass of other information that the alloy No. 4 (aluminium-copper castings) are miscible in all proportions with the corresponding forgings. The alloy No. 12 is miscible in all proportions with the alloys No. 8 (aluminum-silicon), No. 10 (aluminum-silicon castings) and No. 11 (aluminum - silicon - copper castings). The diagram also shows that the groups No. 13 (aluminum-magnesium) No. 15 (aluminum-manganese) and No. 17 (aluminum - magnesium - manganese castings) must not be mixed with aluminum alloys containing copper. The same applies to the alloys Nos. 7 and 9 (aluminum-magnesium - silicon alloys forged and cast). The alloys Nos. 7, 9, 13, 15 and 17 are characterized by a high degree of corrosion resistance and mechanical strength which would be deteriorated more or less by the addition of copper.

The second type of alloys (limited degree of miscibility) is represented by the group 15 (aluminum-manganese) in connection with group 13 (aluminum-magnesium) and group No. 17 (aluminum-magnesium-manganese castings), which can be mixed to a certain limited extent, although this should be avoided wherever possible since alloys containing magnesium should not contain manganese beyond a certain limited amount depending on the magnesium contents and on the ultimate purpose of the alloys to be produced.

A very important feature is to keep the alloys of the group No. 8 (aluminum-silicon alloys of the Alpax or Silumin types) or other aluminum alloys containing larger percentages of silicon away from the alloys included in the groups Nos. 13, 16 and 14 (aluminum-magnesium and aluminum - magnesium - manganese alloys) since mixtures of these alloys are bound to be hard and brittle. The same applies to the mixtures of the alloys 13, 14 and 16 with the alloys group No. 7 and 10.

It is practically impossible within the limited space of this article to point out all the possibilities and alternatives of information yielded by this diagram, and it is suggested that colored charts are prepared for this purpose even for superintendents and metallurgists since this clearest and most intensive means of distinguishment always proves to be the most efficient aid in studying the variety of information contained.

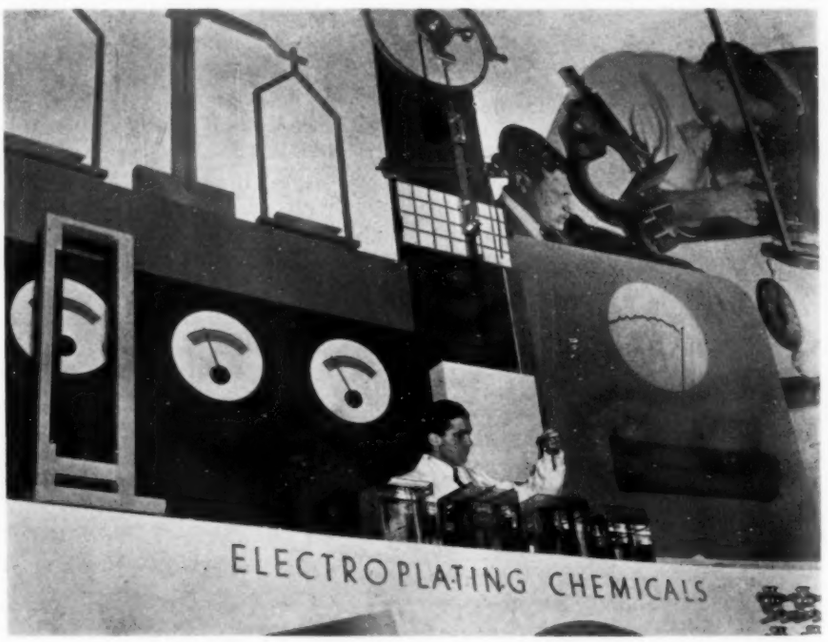


Exhibit of electroplating chemicals of E. I. duPont de Nemours & Co., at the World's Fair, New York.

Recent Developments in

Solvent and Vapor Degreasing

By Carleton Cleveland

The author presents a resume of the latest developments in vapor degreasing. The type of cleaning, choice of solvent and the degreasing machines are described.—Ed.

Solvent and Vapor Degreasing, as they are known today, are of comparatively recent development. While it has long been known that the proper preparation of metal surfaces —both ferrous and non-ferrous—for the application of protective and decorative coatings was a matter of prime importance in the finishing of many manufactured products, it remained for recent engineering and chemical research to develop and perfect the present day methods of scientific degreasing in its application to industry.

Types of Dirt Removed

The adhering materials encountered in industrial processes, which must be satisfactorily removed before any plating or finishing operations can be attempted, may be said to consist of:

1. Organic materials such as oils, greases, soaps, or lubricants used in processing operations.
2. Inorganic substances such as scale, rust, tarnish, corrosion, and other oxide formations.
3. Polishing, buffing, and coloring compounds (organic base plus inorganic fillers).

It is the first classification, that of organic materials, with which we wish to deal here. For the purpose of being more specific, this organic group may be broken down into saponifiable

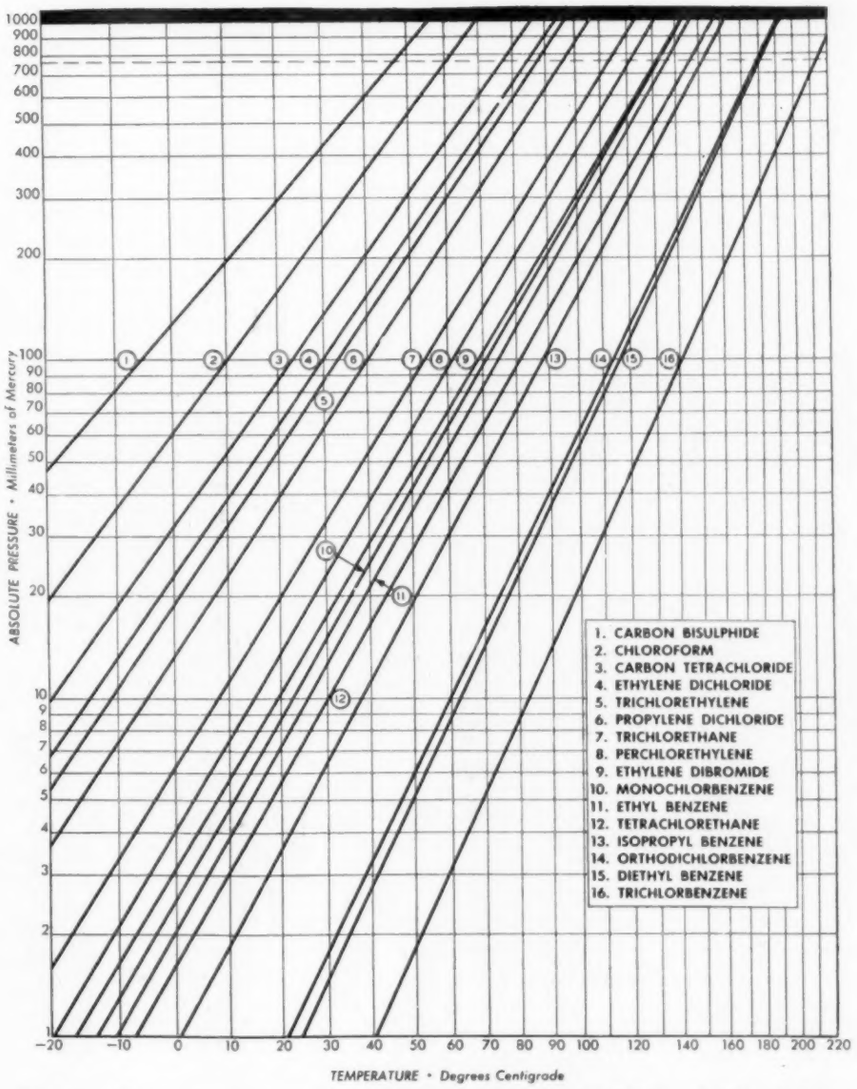


Fig. 1. Vapor pressure curves of organic solvents including trichlorethylene and perchlorethylene.

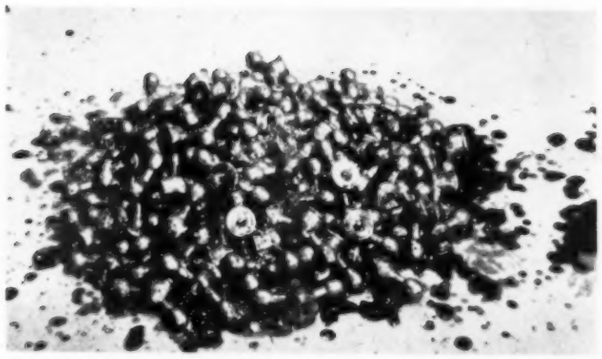


Fig. II. Machined brass castings with chips and a heavy coat of oil.

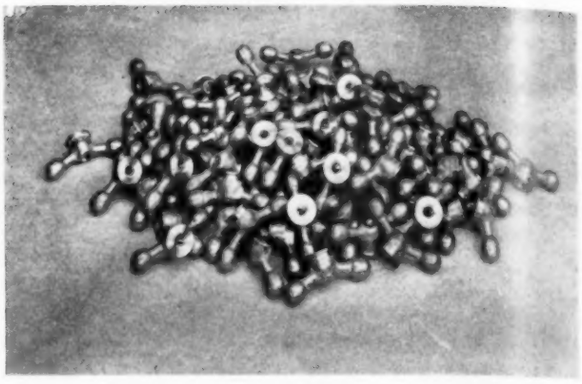


Fig. III. Castings in Fig. II after they have been cleaned in a degreaser.

and non-saponifiable substances. The saponifiable oils and greases, such as animal and vegetable fats are readily removed in some alkaline solution, producing a soap soluble in water. The non-saponifiable group, on the other hand, commonly consisting of the straight petroleum products, mineral oils, and similar substances that do not react readily with alkali solutions, except by emulsification, require other methods in which certain organic solvents have been found suitable for dissolving and removing this foreign matter. However, the solvents used in cleaning or degreasing the non-saponifiable group may also be used with equally good effect on the saponifiable group.

Formerly non-saponifiable organic matter was removed by using gasoline, kerosene, and benzine, all known to be inflammable and considered injurious to the health and well-being of the operator. Today, the solvents commonly used in industrial degreasing are not only more efficient, but non-inflammable and hence less dangerous to safety. Former methods were all costly and inefficient with heavy loss and wastage of the solvent used.

Solvents Used for Degreasing

The research activity of the industrial chemist has played an important part in the development and improvement of both the chemical solvents in present day use and the perfection of the equipment used in liquid and vapor degreasing. Investigations in the laboratory, together with experience in actual degreasing operations, have revealed that the chlorinated hydrocarbons are the most suitable and adaptable for this class of work.

Despite the fact that the chlorinated hydrocarbons are considered sufficiently stable for commercial use in a wide variety of other applications, there are some conditions that may tend to bring about a breakdown of the particular chlorinated hydrocarbon member being used for industrial cleaning with the possible resulting formation of acidic decomposition products. To safeguard against such possibilities, studies have been made of the peculiarities and characteristics of each member of the group to ascertain the conditions under which it might be used without the tendency to decompose or cause corrosion of properly designed and constructed equipment.

Of the various members of the chlorinated hydrocarbons, choice seems at present to center on trichlorethylene as being most practical for use in vapor phase degreasing. Although a number of metal degreasing solvents are sold under various trade names by both chemical manufacturers and the designers and builders of degreasing equipment, they consist substantially of trichlorethylene. Ethylene dichloride and carbon tetrachloride have also been used with varied success, but for general metal degreasing, both hot liquid and vapor phase, perchlorethylene and trichlorethylene are the approved solvents, although the various solvents having trichlorethylene as the principal solvent appear to have the preference at present, due to its efficiency in cleaning and low heat requirements.

Trichlorethylene is, by no means, a new product, having been first recorded in the literature several decades ago. It was made by the reduction of hexachlorethane with hydrogen generated by the action of dilute sulphuric acid on zinc. It was first produced commercially in Germany in 1910, but is now made on a large scale and in purer form in this country. It is considered a solvent for stearic acid, paraffin wax, tallow, pitch, caffeine, olive oil, cocoa bean oil, corn oil, linseed oil, soya bean oil, bone grease, garbage grease, wool grease, mineral oil, and many other organic substances. This property, coupled with its sharp boiling point showing a high degree of purity, and its low heat capacity, make trichlorethylene well suited to be used in solvent degreasing units, including vapor, immersion, or spray cycles or phases.

Although trichlorethylene, at the

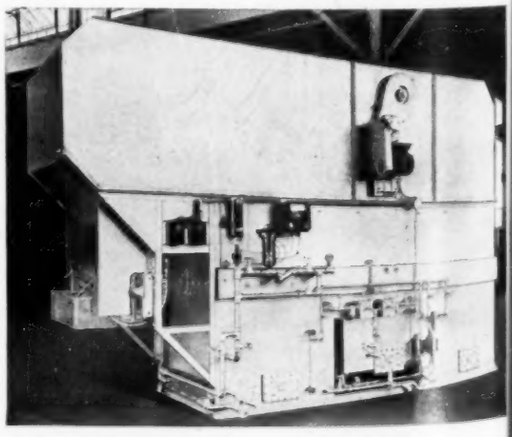


Fig. IV. Automatic three-dip type degreaser with cross-rod conveyor, automatic control, and arranged for loading and unloading at one end.

temperature required for metal degreasing, is non-inflammable and non-explosive, yet at higher temperatures such as occur in open flames, electric heaters, arcs, and burning tobacco, the vapors from the solvent may decompose to form toxic and corrosive substances. To guard against the formation and possible accidental inhalation of such vapors, it is well to have the combustion products from any open flames vented so as to be disseminated outside the building, and persons should be cautioned against smoking in the vicinity of the degreasing equipment containing chlorinated hydrocarbons. Since all gases and vapors, other than pure air, are said to have a physiological action upon the human system, any operation involving the use of chlorinated hydrocarbons, as well as any other volatile material, should be carried out with every precaution to safeguard the health of workers.

The modern solvent degreasing units sold by responsible equipment manufacturers are designed so that when properly maintained and operated, no noticeable concentrations of solvent vapors are present even in the vicinity of the degreaser. The presence of any such concentrations indicates improper methods of operation or unsatisfactory conditions in the degreasing unit. If the odor of the solvent is noticeable in the vicinity of the degreaser, or if any of the operators develop symptoms of nausea, dizziness, headache, and general ill feeling, the degreasing unit and the method of operation should be checked in detail with the equipment or solvent manufacturer, and any unsatisfactory conditions or unsafe practices should be corrected immediately. Ordinarily, forced draft ventilation is not required with degreasing units, but in special cases, it may be necessary to provide mechanical ventilation, so as to disseminate the solvent vapors safely outside of the building. Containers of solvent should remain closed when not in use, and all such containers should be stored in a cool room with the bung or outlet up.

Modern Degreasing Machines

Present day degreasing equipment consists of a specially designed tank of welded construction, galvanized or metallized on the inside after fabrication, in which the boiling solvent and controlled saturated vapor column are maintained. In modern solvent degreasing processes, the solvent may be used not only as a liquid wash but also in the form of its saturated vapors, or in a combination of both forms. The different forms are sometimes spoken of as:—vapor, liquid immersion, liquid spray, and a combination of both liquid and vapor, or spray and vapor.

The simplest type of degreaser is the straight vapor machine, consisting of two parts of a single chamber —a heating and a vapor zone. Here the vapors must be controlled to prevent their rising to the top of the chamber and escaping from the machine. Loss of the solvent is caused by diffusion and mixing of the solvent vapors with air. Such an occurrence (excessive disturbance) at once tends to increase the operating cost of the process, since when mixed with air the vapors cannot be controlled and are impractical to recover.

In the scientifically designed machine, a steady vapor level is maintained by means of a condenser in the form of a water jacket or a series of coils that encircle the machine, providing a concentrated cooling area at the proper location. Not only does this condenser serve to cut the evaporative area and prevent the diffusion of the solvent vapors into the air, but it also provides a cushioning effect for rapidly leveling the vapors disturbed by the movement of the work into and out of the degreaser.

In the operation of the modern equipment used in vapor degreasing the chlorinated compounds heated in the lower part of the chamber give off vapors that rise in the chamber to a level half way up the cooling coils or water jacket. When the cold metal objects to be cleaned are immersed, the pure vapors condense immediately on the cold metal, causing the oil and grease to dissolve and to be flushed

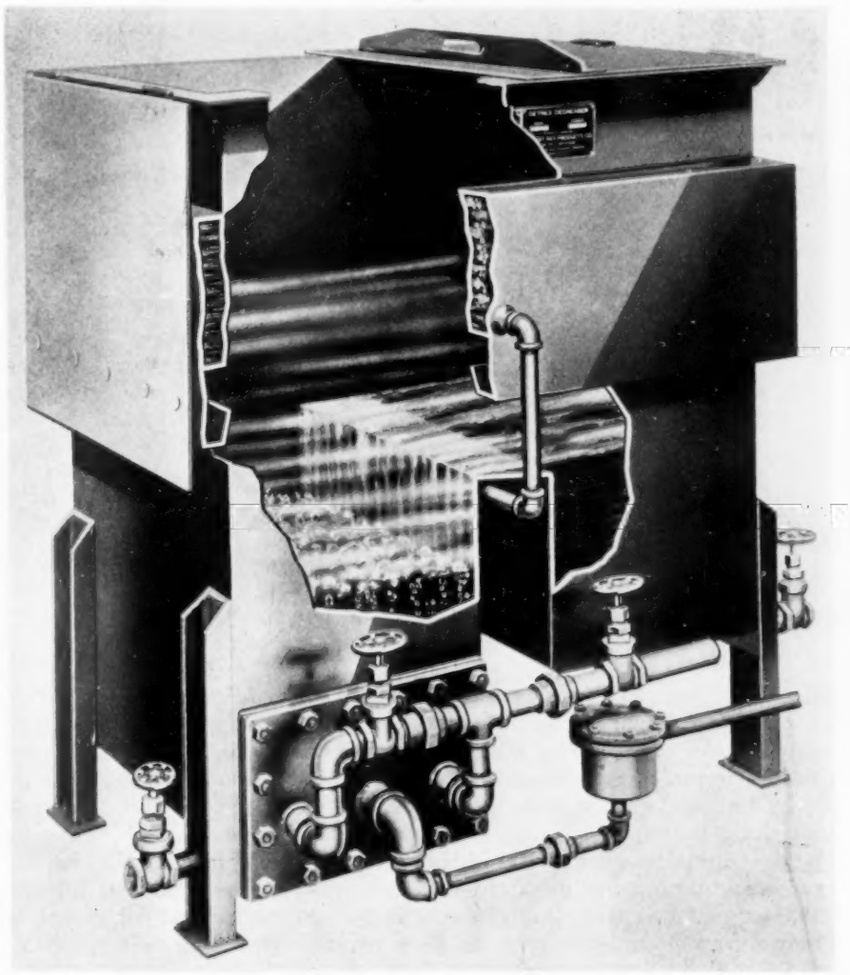


Fig. V. Cut-away view of a two-dip type, steam heated degreaser, showing solvent levels in both chambers and vapor space above the boiling chamber.

from the surfaces, dropping into the boiling solvent below. This condensation continues until the metal reaches the temperature of the hot concentrated vapor. The important advantages of the vapor method are: Its extreme simplicity of operation; only pure vapors reach the work; and that the work on emerging from the vapor chamber is not only free from oil and grease but warm and dry and ready for finishing operations. Vapor degreased work can generally be stored for short periods, if necessary, without danger of tarnishing. A complete cleaning cycle generally requires less than a minute.

Since there is practically no mechanical action present in vapor cleaning, the amount of insolubles removed is almost nil, as compared with other phases of degreasing. While oil, grease, and wax may be removed in the vapor (if the gauge of the metal is heavy enough to give a flow of condensate sufficient to dissolve and flush off all the solubles), pigments, lint, buffing compounds, shop dust, or metal particles may not be affected. In other words, the metal surfaces may be degreased but not made chemically clean.

When unusually dirty parts with heavy grease deposits, or parts of too light a gauge for simple vapor cleaning are encountered, the cleaning may be quickened by first immersing the work in the hot liquid; or the pure warm solvent may be pressure sprayed on the parts as they hang suspended in the degreasing chamber, after which they are given a vapor rinse. The continuous sweep of the boiling solvent over the work gives a washing and scrubbing action that assists in the removal of insoluble solid particles. This dual use—liquid immersion-vapor—has led to the popularity of a certain type of degreaser in industry. This is commonly designed with either two or three separate chambers.

The usual sequence of cleaning operations in these machines is immersion into the boiling solvent, after which the work is transferred to a chamber containing clean cool solvent (about 26° F. lower than boiling point) to rinse and cool the metal, which in turn is followed by suspension in the vapor space over the two compartments.

For some types of work, degreasing machines must be built with three chambers, one each for hot and cold solvents, and a separate compartment for pure vapor. For cleaning light gauge stampings, closely nested parts, buffed and ground surfaces, or other difficult cleaning jobs, the three-tank machine is generally used. The parts are first immersed in the boiling solvent long enough so that all surfaces are reached and all grease is dissolved. Thereupon the work is transferred through the vapor layer and into the second compartment of solvent (this usually is not heated). Here the solvent penetrates, rinses and chills the metal, and when it is placed in the third compartment of pure vapor, condensation takes place and an absolute rinse is obtained. In the vapor, the work is brought up to the temperature of the vapor and is then allowed to drain, after which it is brought out clean, hot, and dry.

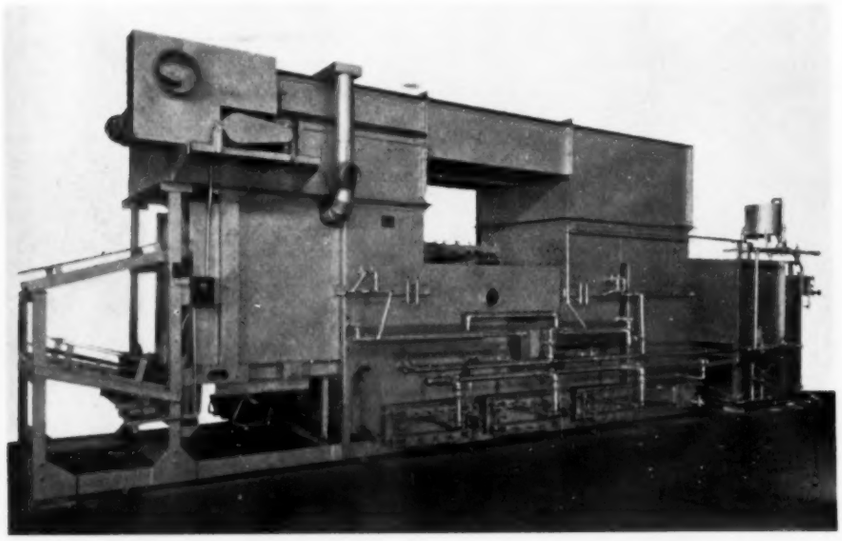


Fig. VI. A completely automatic four-tank degreaser with storage tank and auxiliary still. No operators are required with this machine since the baskets are automatically loaded and unloaded.

Large production may require an automatic type of degreaser with an independent conveyor of perhaps a continuous monorail type, built to fit into the production line. This automatic machine may be so designed that loading and unloading is accomplished at one end of the machine, or the conveyor may take loaded baskets at one end, discharge them at the other, and then return to the loading point. Since solvent degreasing has become a standard cleaning method in industry, frequently machines have been specially designed to meet the specific needs of a manufacturing plant, an example of which would be that for cleaning continuous strip steel, aluminum, and wire.

Many degreasers are designed to be self-distilling for reclaiming the solvent after contamination. That is, the degreaser itself can be used to distill and thus purify the solvent at intervals when necessary. However, for the larger degreasers, particularly in plants where it is not desirable to interrupt production or where the oil or contamination is very heavy, auxiliary solvent stills are usually installed. A still is used to remove solids and oil contamination from the solvent after or during use. They are equipped with a separator for removing water with which the solvent may have become contaminated, and are designed so that they may be run continuously or intermittently, as desired.

ACKNOWLEDGMENT

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The Application of Hard Chromium Plating

By R. M. Goodsell

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A practical paper by Mr. Goodsell, president of the American Electroplaters' Society, who has had years of experience in the application of hard chromium plating. The treatment of the basis metal, the nature of hard chromium deposits and the many uses for hard chromium plating such as for files, gauges, bearing surfaces, cutting tools, molds, etc., are described.—Ed.

Introduction

The metal working industries of the United States are one of the most important and far reaching of the basic industries; at the same time, they are probably one of the least understood by the general layman. The reason is simple. The metal industry is not narrowed to any particular product. It is a rambling disjointed aggregation of manufacturers, covering a wide variety of metals, processes and products, weaving through practically all industries in every conceivable form.

Nevertheless, they all have a common origin; namely, "Metal Ore." After mining and subsequent refining, rolling, drawing, stamping, casting and machining, they are all susceptible to the same methods of finishing. The finishes include grinding, polishing, electroplating, painting, enameling, lacquering, chemical coloring and japanning, each of these being divided into many operations to obtain a given product.

In referring to literature regarding chromium, we find these facts. Chromium is found as an oxide principally in Rhodesia, British India, and New Caledonia and the U. S. imports amount to 400,000 metric tons annually. Like other metals, it has a crystalline structure, a greyish white appearance, and is not appreciably ductile or malleable. Its principal users are the steel manufacturers. It is used in percentages of from 8% to 40% in stainless steels, about 1% in chromium-vanadium steels, 13% to 15% in chromium-nickel corrosion and heat resisting steels, and from 0.1% to 1% in chromium steels.

R. M. Goodsell

A large amount of chromium in the form of chromic acid is used in the electroplating of decorative and hard chromium plate.

Nature of Hard Chromium

Hard chromium is entirely different from decorative chromium in nature and is always plated directly upon the base metal, which is most frequently, steel. It is of two kinds, one known as flash plating, the other heavy or specification plating. Flash plating is of a thickness up to approximately 0.0005". (Note the difference from decorative which is of the order of 0.00002"). Flash plating is not usually finished by grinding or lapping to size afterwards.

Heavy plating differs only from flash plating by being thicker. The preparatory cost is the same for both.

Research has brought out a few of the characteristics of chromium, which when applied as hard plate make it desirable for use by manufacturers of many products, where wear, corrosion or erosion are troublesome. Hard chromium deposited upon base metals will withstand high temperatures, as its melting point is 3326° F. It is resistant to corrosion by ammonia vapor, hydrogen sulphide, and all acids except hydrochloric or dilute sulphuric acid. It is not immune to chlorine products, or processes in which chlorine of any quantity is used.

The hardness of chromium varies greatly with the conditions of deposition. However, the hardness obtained by electrodeposition is far greater than that attained by any treatment of the solid metal by metallurgical processes. The hardness of electrodeposited chromium may vary from 400 to 950 Brinell hardness numbers.

It is difficult to determine the hardness of thin deposits of chromium because the thin shell of chromium breaks through, due to the relatively softer structure of the underlying metal, even a hardened steel, and therefore, the normal penetration methods for determining hardness are of no value for thin coatings. However, some estimation of the hardness of thin coatings can be made by means of the diamond scratch hardness tester.

The hardness of chromium is due probably to the fine grain size and the condition of strain of the crystal

lattices. The presence of hydrogen has some influence on the hardness but foreign workers have shown that most of the extreme hardness of chromium is maintained even after almost all of the hydrogen, dissolved in the lattice, has been expelled.

Applications of Hard Chromium Plating

Hard plating is not easy to do and involves much detail which is not necessary for decorative plating. Its successful operation depends upon a rather extensive knowledge of the electrochemistry involved. Many elements enter into this particular operation. Of prime importance is the chemical control of the electrolyte, which is maintained by constant analysis. Of equal importance are the special electrical generators required by the enormous current demands; also the sensitive, automatic temperature controls to maintain constant temperature. so necessary to precision plating.

As it is necessary to deposit the plate evenly, regardless of the shape of the piece being plated, ingenious and complicated racks for holding the parts have been developed. Much time and research have been spent on the mechanics of properly designed racks and anodes. These racks require carefully calculated distances between the anodes and parts to be plated, and the use of so-called "thieves" to prevent excessive build-up of plate on corners and edges. The success of the plate, in a great measure, depends upon the design and building of racks.

Another important phase in hard plating is masking. This process involves protection of certain parts of a sample which must be completely submerged in the electrolyte. This protection is accomplished by means of masking with materials which are not affected by the bath. The time of plating is calculated by the number of thousandths of an inch of plate necessary to be deposited on the article. The rate of deposition varies with current density used and on the contour of the part.

Industry has realized that a vast amount of ferrous materials are wasted each year because of corrosion. Statistics, given by eminent authorities, prove these losses are in excess of $300,000,000 annually. No one knows or would venture a guess on the monetary losses on sub-assemblies that have been nearly completed at a great expense, and then rejected because of faulty machines. There is no reason today why many of such losses should prevail in industry, providing the thought was retained in the mind of the executive that there is a remedy for many of these errors.

In every plant there is a problem, which has a vast bearing on cost systems; namely "overhead." Ways and means of reducing this item have become a necessity in order to meet increased taxation and costs. Formerly, machined parts, involving considerable cost in labor and material for their production, were delivered to the scrap heap instead of to the customer, because too much stock had been removed in the machining operation. Where is the apprentice who at some time or other was not sent for the dimension stretcher after such a blunder? However, this joke is obsolete as we now have at our command just such a tool. Today we have this tool in the form of hard chromium plate. This method is being used to salvage tools, machine parts, etc., and as a result these parts are saved from the scrap heap, at a fraction of their original cost.

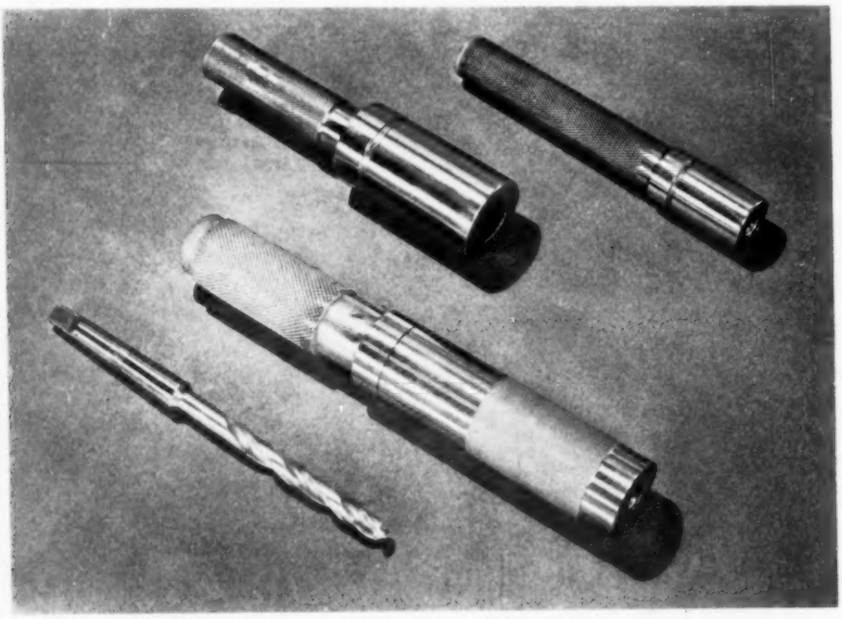

Figure 1. Chromium plated plug gauges. One with 0.030″ *of chromium and two with* 0.008″ *of chromium. All are ground to size. The drill has* 0.0002″ *of plate.*

Uses for Hard Chromium Plating

Experience has shown that tools and gauges hard plated will withstand abuse and wear for an exceptional length of time, and surfaces that have been plated with hard chromium are readily finished to a high degree of smoothness by grinding and lapping. It has been found that any degree of accuracy that can be produced in steel, can be reproduced on chromium plate. The process very often tends to lessen the labor required to maintain the accuracy necessary on some types of tools.

An example of this condition was found in the manufacture of test bars, such as are used to test the alignment of crankshaft bearings on automobile engines. It was found that these test bars were more difficult to produce in solid steel than when plated. To be of the greatest usefulness in service, these bars must have a wear resistant surface. When it was attempted to obtain the necessary wear resistance by heat treatment alone, the bars were usually either very difficult to grind or were distorted after grinding by the stresses left by heat treatment. The hard chromium plating of such a tool, when new, permits the selection of steels and heat treatment best suited for the purpose and a wear resistant surface is provided. In this manner, the bars are somewhat easier to grind than when unplated, as they do not possess the tendency to warp and twist during this operation.

The general principle to follow when

desiring to have parts hard plated, is to use the grade of steel which can satisfactorily perform its operation. For example, when chromium plating is used, it is perfectly feasible to use soft steel for gauges, instead of hardened steel. The limiting factor, however, is the physical properties of the base metal. The base metal must not be so soft as to allow deformation due to impact or other forces to which the tool is subjected.

It is common knowledge among the tool and machine manufacturers that a part of tool, die or machine can be made too hard for the purpose for which it is intended. The part also can be hardened, but not drawn with the proper care, thereby leaving what is known as residual hardening strains in the part. When hardened steel parts are to be chromium plated for wear and resistance to corrosion, it is imperative that it be as free from hardening strains as possible. In order to secure this condition it is necessary to exercise careful supervision over the heat treatment and mechanical design of the part to be plated.

The reason for this care on the part of the manufacturer is two-fold. When it is required to deposit a hard chromium plate on the part to the extent of 0.005″ or over, it means that the part will be exposed to the action of the electrolyte for hours, and during the plating period there is a violent evolution of hydrogen gas in close proximity to that part. It is only natural that a part of that hydrogen is included in the plate, and this tends to increase the hardness of the plate.

It can readily be seen, that if the heat treatment has not been properly accomplished, and the part has been left too hard, that the action of the electrolyte and hydrogen would, in all probability, cause the part to be defective in the final finishing operations.

While the hydrogen that might be included in the deposit might cause difficulties in final grinding and lapping, there is a remedy that can be employed, and that is to subject the part to a temperature of 300° C. (570° F.), which tends to expel the hydrogen in the deposit. This process does not take away any of the hardness or value of the hard chromium plate. Then grind or lap the surface of the plated part. Finer results are obtained this way on all hard chromium deposits.

It is a common practice among many users of gauges and high precision non-cutting tools which are subjected to extensive wear, to salvage them by hard chromium plating. The procedure is to grind them 0.0025″ undersize on an outside diameter, or oversize when an inside diameter. An excess of hard chromium is then deposited on the surface that is to be restored, and the part is reworked just as if it were new, and had just been heat treated. Parts of intricate shapes that are subjected to excessive wear are thus salvaged by hard chromium plating at a fraction of their original cost.

The practice of salvaging worn tools and gauges is generally accepted by the industries of today, but it seems that the advantages of plating new tools are still not recognized by many firms. It has been found that it is much easier to include the plating in the original cycle of manufacturing operations than to make a separate job of it after the part has been used.

Cutting Tools

There have been various tests made as to the value of hard chromium plating on tools for cutting, and while some have not shown enough advantage to warrant their cost, others have more than tripled their life. Tools which have been plated in the largest quantities are drills, reamers, taps, milling cutters, and mills, counter boring tools and forming tools of various designs, such as are used on turret lathes and on automatic machines. The cutting tools mentioned are being used to cut ferrous and non-ferrous metals, such as cast iron, malleable iron, mild steel, brass, copper, aluminum and die-cast zinc. They are also used in the cutting of materials such as bakelite, hard rubber, wood, marble, plastics and slate. It is readily discernible that hard chromium plated cutting tools are finding application in machining practically all the materials used in industry.

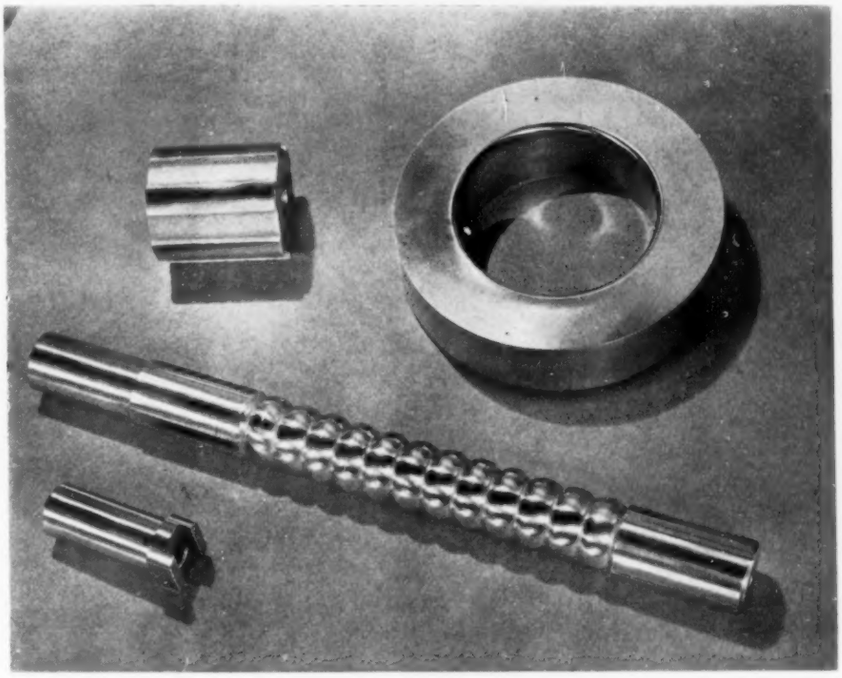

Figure II. Chromium plated drawing dies with 0.0015″ *on a side. Burnishing broach and the quenching plug are also chromium plated.*

Files

An interesting report from one concern stated that chromium plated files were responsible for a twenty per cent reduction in finishing cost on a given amount of production, and also that they were much more acceptable to the worker than the unplated files. The principal advantage of this type of application seems to be in the difficulty of adherence of other materials to a chromium surface.

Molds

Another class of work which has

Figure III. Chromium Plating of Briquet Dies Resists Wear.

With the growing popularity of coal briquets and the crowding of the briquet making machinery at coal yards furnishing fuel in this form, rapid wear is being noticed on the dies, requiring frequent regrinding. Several midwestern briquet makers have discovered a way to cut their costs considerably, but also to avoid delay while the briquet machine is being repaired due to worn dies. This saving of time and expense is accomplished by means of extra hard chrome plating of the dies.

One of the largest briquet makers in Wisconsin, at Kenosha, found such saving of expense and time possible by having the dies of the briquet machinery chrome plated. It was found that even where the construction of the briquet roll is of sufficient strength, considerable expense was involved in keeping the briquet dies in shape, due to rapid wear under heavy production. By the application of 0.010" of hard chrome, the surface of the dies was built up to a very high Brinell hardness. It was found that this application of hard chrome reduced the wear and permitted a reduction in cost of maintenance, not only in the regrinding process but also in preventing the delay in production of briquets, which as can readily be seen is a very important factor.

overcome difficulties by the use of hard chromium plate is the plastic industry. By surfacing the molds, which are used for hard rubber and plastics, with chromium, some real advantages have been found. Pitting of the surface by sulphur compounds is eliminated; rubber and other plastics do not stick to the chromium surface of the mold; corrosion of the mold while in storage between runs is eliminated, wear in the cavities is much reduced, resulting in greatly increased life; and finally, there are some plastics which corrode steel so rapidly that stainless steel or chromium plated ordinary steel must be used for molds to produce a satisfactory product.

Thickness of Deposits

The thickness of chromium used on parts subject to wear, varies much with the services expected. Some small parts used on textile winding machines may have three or four times the life of unplated parts with only 0.0002" of chromium. Another part used on the same machine may require a thickness of 0.001" or more to give best results. Rolls used for finishing cloth, producing an inferior grade because of intensive wear, were considered good if they finished 75,000 yards. The rolls of one machine for this particular job were hard chromium plated with a 0.005" deposit as a trial, and were still in operation after running 8,000,000 yards. Another instance in which chromium plating was of extreme value was in a large power plant. This plant had considerable trouble repacking pump shafts. This was causing an unnecessary expenditure necessitating reserve pumps at all times. Hard chromium was tried, with the result that a smooth chromium plated surface on the pump shaft practically eliminated packing renewals.

Spindles of grinding machines are usually ground undersize, plated oversize, and ground back to the desired diameter, leaving the hard chromium between 0.002" or 0.003" in thickness. Parts on packaging or wrapping machines are often plated with from 0.003" to 0.005" of hard chromium to protect them from corrosion as well as wear.

Other Uses for Hard Chromium

Parts plated with chromium for resistance to abrasion, corrosion, friction

and wear are being used on many other types of machines, including lathe carriage V's, feed screws, gibs, slides, gears, bushings, shafts, pumps for gases, liquids and semi-solids, pneumatic tools, airplane engines, can making and filling machinery, cereal processing equipment and machines used in the tobacco and leather working industries.

The use of chromium on forming and drawing dies will increase their life, assure accuracy and eliminate draw marks and metal build-up on close work.

Other uses for hard chromium plate improving quality of product and resistance to the elements, are found in the paper mill rolls. It has produced a substantial saving in the maintenance of paper mill equipment. Here, resistance to wear and corrosion has pro-

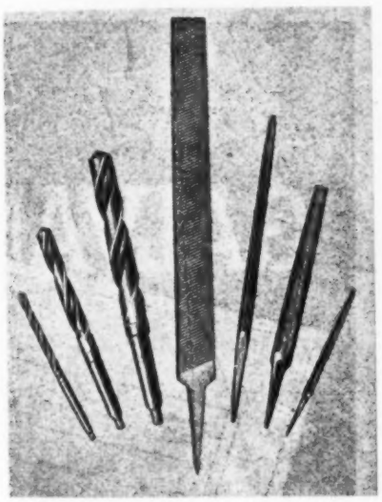

Figure IV. Chromium plated files and drills.

longed the life of the parts many times. However, if chlorine or sulphuric acid are used in excess in the manufacturing cycle, it is not advisable to use chromium, as it will not hold up, but there are other plated coatings that can be used that will be more satisfactory than the iron or steel roll.

Chromium plated dies for drawing wire and tubing have given excellent results because of a better finish, and elimination of the tendency of scale or chips to cling to the dies and mar the surface of the product.

Two steel surfaces sliding together with considerable contact pressure develop tremendous friction. If one of the pieces has a babbitted surface, friction is reduced considerably. Yet a chromium surface rubbing on chromium has a friction loss only one-half that of the steel on babbitt. Chromium plate in the form of hard chromium meets severe wearing conditions with those two-fold characteristics, exceptional hardness and low coefficient of friction.

The close control methods employed in the hard chromium process have been resolved almost to laboratory methods with the result that more and more information is being compiled on the subject. It has been found that many difficult jobs of a few years ago, are but ordinary jobs today, and new uses of the hard plate process are constantly being revealed. It may be that many of today's impractical jobs, such as new types of cutting tools, will be merely a part of the day's work for the plater of tomorrow.

When considering having some part chromium plated, it will be well to remember the following points, as they go a long way toward a satisfactory result.

Care should be exercised in the selection of proper grinding wheels when preparing a part to be hard chromium plated. The mistake is usually in the choice of too hard a wheel. Grinding checks, caused by clogged grinding wheels, grow to a very alarming stage in the surface appearance after the deposit is on, and necessitate removing more of the valuable deposit to gain an even surface.

Perhaps the most frequently overlooked factor in the successful application of hard chromium plate, is the consideration of the physical properties of the underlying base metal. These are the metallurgical factors.

It would be safe to say that 50% of the failures of hard chromium plating have been due to the lack of complete knowledge given the plater as to the use of the part plated. It is very important that the plater is given the analysis of base metal to be plated, when possible, and the purpose for which it is intended, and any special conditions which are to be overcome. A close adherence to this rule will produce a better product and will enable the plater to know the grade of plate to apply.

In closing, a word about the proper grinding wheels for finishing hard chromium. Due to the hardness and density of chromium, the leading abrasive wheel manufacturers have developed special wheels for this type of grinding, which make chromium as easy to grind as steel. It can be ground wet or dry according to the part, and while difficult to lap, a finer degree of finish can be obtained by that method.

Results now being obtained are as closely accurate as it is humanly possible to achieve under present conditions, and customer satisfaction is growing by leaps and bounds.

In presenting this paper we have endeavored to cover the field in which hard chromium plate has been of value, and we are sure that the uses to which it has been applied are but a scratch on the surface in comparison to benefits it can render to the industry in general, when its true value is recognized.

(CONCLUSION OF REFERENCES FROM ROUTINE TESTS FOR TINPLATE, PAGE 406)

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PLATING AND FINISHING
FABRICATION — ASSEMBLING
METALLURGICAL — ROLLING
CASTING AND JOINING

SHOP PROBLEMS

Technical Advisor For September Issue

G. B. HOGABOOM, JR.

Consultant in Electroplating and Metal Finishing, Newark, N. J.

Bronze Plating of Die Castings

Q. I am enclosing a sample of a bronze plating solution and a sample of the work and you will see that the work has an uneven smutty finish which I would like to eliminate. At a high current density, the color is too brassy but this difficulty can be overcome by agitation.

A. The composition of your solution is:

Copper, as metal	4.4 ozs/gal.
(as copper cyanide)	6.2 "
Zinc, as metal	0.24 oz/gal.
(as zinc cyanide)	0.43 "
Free sodium cyanide	1.3 ozs/gal.

The solution is too concentrated. Also, the free cyanide is too high for good results. The high free cyanide will tend to allow the deposition of zinc, over that of copper, especially at high current densities.

The Plating & Finishing Guidebook, 1939 edition, page 16, gives a formula for a bronze that contains copper cyanide—4, zinc cyanide—0.3, sodium cyanide—5, and rochelle salts—2 ozs/gal. To bring your solution to this composition, it will be necessary to remove 1/3rd of the solution, and add water. This is preferably done by decanting off the top 2/3rds of the solution into clean containers (steel drums) and discarding the bottom third. Clean out the tank, return the clean solution and make up with water.

Rochelle salts are added to aid anode corrosion. The total amount should be about 2 ozs/gal. When the anodes turn dark and polarize, it is necessary to use higher voltage to get current through the tank. The higher voltage will cause the anodes to more nearly completely polarize and a point is soon reached where only a small current can be pushed through the solution. This will result in poor character of deposit. Good control cannot be had by using mixed copper and brass anodes. The different composition of anodes hanging in the same solution will cause local currents to be set up between them and cause changes to occur even while the solution is idle. Your anodes should be brass of 92% copper, 8% zinc composition.

—G. B. H., Jr.

Tarnishing of Silver Plated Reflectors

Q. We have been endeavoring to oxidize a small metal shield to be placed in front of a bulb in an auxiliary driving lamp used on automobiles. The reflector in these lamps is silver plated. The shield which we are using is manufactured from brass.

We find that the sulphur fumes from the oxidized brass shield causes the silver plated reflector to tarnish.

Will you please let us know how to overcome this difficulty?

A. There is no doubt that the tarnishing of the silver plate on the reflectors is due to the sulphur which is volatilized by the heat of the bulb. Silver is extremely sensitive to sulphur and in some cases even paper will cause silver to tarnish. There are three possible ways in which your difficulty can be overcome.

1. Use a non-sulphur type of oxidizing solution: as for instance, a brown color can be produced by the use of copper sulphate and potassium chlorate as mentioned on page 51 of the 1939 edition of our "Plating & Finishing Guidebook."

2. Use the same type of oxidizing solution which you are now using and coat the silver with a clear protective organic coating which is resistant to sulphur fumes. This, however, is frequently unsatisfactory because the coating usually turns brown.

3. Protect the oxidized finish with a clear lacquer which is non-permeable to sulphur.

—W. R. M.

On Analytical Solutions

Q. I have been studying the method for determining boric acid in nickel plating solutions as published on page 74 of the 1939 Plating and Finishing Guidebook. I would like to ask the following questions on analysis:

1. How much sodium cyanide is required in grams to make a 10% solution?

2. What is the proper amount of hydrochloric acid assaying 38% to make up a 10% solution?

3. Is one-half cc. of bromcresol purple as recommended equal to about 5 drops with a medicine dropper?

A. 1. The proper weight for a 10% solution of sodium cyanide is approximately 105 grams dissolved in one liter assuming the sodium cyanide to be 95%.

2. A 10% solution of the acid which you are using can be made by mixing 100 cc. of the acid with 280 cc. of water. In the 100 cc. of acid will be 38 grams of HCl, which when diluted to a total of 380 cc. or grams, is as you can see, a 10% solution.

3. Ordinarily, there are about 20 drops to a cc., and ½ cc. would be about 10 drops. Of course, the size of the drop depends, to some extent, upon the size of the tip of the dropper or burette.

—W. R. M.

ELECTROPLATING DIGEST

SELECTED ABSTRACTS ON PLATING—F'NISHING—RUST PROOFING—LACQUERING

A Resume of Indium Plating

Joseph B. Kushner, Ch. E.

One of the newer metals for the consideration of the electroplater is indium. Indium was discovered by the German chemists F. Reich and T. Richter in 1863 but it is only since the early 1930's that the metal has become available in the commercial sense of the word. Though a comparatively rare metal, present production of the element is well over 100,000 ounces per year and its selling price is in the neighborhood of a dollar per gram.

Indium possesses several interesting properties that perhaps in some way may be taken advantage of by the plater. It is a silvery white metal resembling platinum in luster. It does not tarnish in air or even under boiling water. Like aluminum (indium is a member of Group 3) in this respect, it seems to form a self-protective coating of extreme thinness which guards it from further attack. It dissolves very slowly in the mineral acids (dilute) and readily forms alloys with gold, silver, lead, tin and cadmium. Indium melts at 155° C. and is a fairly light metal (specific gravity—7.3). Its chemical valence is three. It is a very soft substance (Brinell hardness about 1). In fact it can be kneaded between the fingers!

In the electromotive series, the point generally of most interest to the plater, it stands above iron and copper but is below zinc. In other words, it is anodic to iron and copper but cathodic to zinc. This would make it an excellent protective coating for ferrous metals, if it weren't so soft and expensive! However, small amounts of it present in other metals seem to improve their workability and corrosion resistance.

Indium was first obtained by electrolysis of the sulfate by L. Schucht[1] in 1880 but the first actual electrodeposition of it was recorded by Thiele[2] who in 1904 deposited it from its salts in a bath acidified with sulphuric acid. He used silver coated cathodes because he claimed that the depositing indium alloyed or amalgamated itself with the platinum.

Dennis and Geer[3] obtained adherent deposits of indium from formic acid solutions of its compounds but not of a commercially useful type. The bath formula as used by them consisted of

Ammonium formate	5 grams/liter
Free formic acid	130 "
Indium as metal	1-7.5 "

Current density 9-12 amps. per sq. dm.

Kollock and Smith[4] made use of solutions containing gelatin and sulphuric acid, sodium acetate and acetic acid, cyanide and tartaric acid and obtained fair deposits.

In 1930, Westbrook[5] published a paper on indium plating in which he gave as a formula for indium plating the following:

Indium sesqui-oxide	200 grams/liter
96% sulphuric acid	120 milliliters/liter
Sodium citrate	250 grams/liter

Platinum anodes are used. The allowable current density is 2 amperes per sq. dm. It is difficult to replenish the bath with additional In_2O_3 as the sequi-oxide is almost insoluble in the plating bath after the bath has been in use some time. The author recommends that the bath be used to depletion and a fresh bath made up whenever necessary. Deposits from this bath are claimed to be dense and compact.

Daniel Gray[6], in 1932, patented a solution for depositing indium, consisting of the hydroxide of indium dissolved in tartaric or oxalic acids. Indium anodes are used.

Murray[7], gives the following plating bath for depositing indium from a cyanide solution:

Indium as double cyanide	5 ounces/gal.
Free cyanide—NaCN or equiv	9 "
Sugar	2.5 "

The deposit is soft, uniform and gray.

In a series of patents, Gray and Murray[8] have covered the deposition of indium from cyanide plating baths. Up to the present, it seems that the cyanide bath is the only practical electrolyte for indium plating. Ordinary cyanide solutions containing indium, decompose after a few days of use, precipitating a complex indium compound, probably the hydroxide of the metal. This fact was first noted by Meyer[9] in 1868 in his book "Das Indium." It was also noted by Kollock and Smith[4] in 1910, when depositing indium from cyanide tartrate baths. This phenomenon is no doubt due to the hydrolysis that cyanide undergoes in aqueous solutions.

Gray [10], in a comprehensive report to the Electrochemical Society in 1934, mentions several inhibiting agents which retard or prevent this decomposition in cyanide solutions, all of which are the basis of his patents. He finds that weak acids such as glycine, or glucose retard or prevent the precipitation of the hydroxide of indium from cyanide solutions. Glycine retards it indefinitely but must be used continually to prevent precipitation and gradually makes the plating bath assume a syrupy consistency, far much too thick for use. He finds glucose the best material for the purpose and has solutions containing this inhibitor that have stood up for two years in his laboratory and are still going strong. He recommends the following bath for indium plating. It is claimed that it gives bright deposits, almost silvery white in appearance.

To make up a gallon bath, dissolve about 120 to 240 grams of indium in a minimum quantity of hydrochloric acid and evaporate to drive off excess acid. Dilute with water and divide the solution into aliquot parts. To one part, add ammonium hydroxide in excess, until the hydroxide of the metal precipitates. Rapidly filter to prevent decomposition, and dissolve the precipitate in a solution containing 600 grams of sodium cyanide (the sodium salt is preferred to potassium salt) and 0.5 gram of dextro-glucose for every gram of indium that has been dissolved. Precipitate the second part with the same amount of ammonia, filter and dissolve in the cyanide solution and so on, down the line, until the whole batch has been dissolved. Now make up with water to one gallon.

The current density permissible, is 1-16 amps. per sq. dm. The temperature may vary from room temp. to 40° C. The evolution of hydrogen gas from the cathode seems to promote good throwing power. Indium anodes cannot be used as they soon become covered with a gelatinous precipitate. Platinum, carbon, or other insoluble anodes are satisfactory. When new, the bath has a cathode efficiency of 100%. This gradually tapers off to 50%, after a period of use. Ammonia acts as a brightening agent, perhaps in the same way as it does in brass solutions. The bath has wide latitude in indium content as well as temperature and current density. At the higher current densities, the indium plate may occlude hydrogen but this is easily removed by a boiling water dip. To replenish the bath, indium salts are dissolved in cyanide, and added as needed.

In the discussion of Gray's paper, an interesting thing is brought to light which may be of some use to the gold colorers. *Indium, when deposited with gold and a little silver, if heat treated at about* 1500° *F. gives a beautiful sky-blue colored gold.*

At present, the only suggested use for indium plating is in depositing it over silver and heat treating in a reducing atmosphere. The indium diffuses through the outermost layers of silver, imparting to it tarnish resisting qualities. However, the alloy has to have about 42% indium to really stand up in sulfide solutions and the color of the alloy varies from greenish hued whites, through yellows and blues, as the per cent of indium increases.

(Continued on page 445)

METALLURGICAL DIGEST

SELECTED ABSTRACTS ON CASTING—ROLLING—PHYSICAL METALLURGY

Tinning Cast Iron

Cast iron is difficult to tin because it contains minute flakes of graphite to which the molten tin will not adhere. It is generally prepared by sandblasting or tumbling to remove scale and sand, followed by brief pickling, and is then electroplated with iron to provide a basis for the tin.

The prepared articles are dipped into a flux solution before being immersed in the bath of molten tin. The most usual basis for fluxes is zinc chloride, and this may be used alone as a strong aqueous solution. It is beneficial, however, to add some 10-20 per cent of ammonium chloride, as this makes the flux more fluid when molten (in which condition it does its work). The surface of the molten tin is covered with a layer of the same flux, through which the articles are immersed, and which effectively removes any trace of oxide before the article reaches the tin.

For high class work, particularly in the case of iron and steel articles, two tinning baths are employed, the articles being dipped in the second immediately after withdrawal from the first. In this case quite a thick layer of flux is kept on the first bath, since it is unimportant if a little remains adhering to the article when it is withdrawn, and the second bath as its tin is less contaminated with dissolved iron gives a smoother and brighter coating. The second tinning bath, when used, should be covered with a small amount of tallow, and must be kept reasonably cool or the coating will oxidize to a yellowish color on withdrawal.

If only one bath is employed less flux is used, so that it may be skimmed aside and the article taken out through a clean surface.

Detection of Solid Contaminants in Air

The techniques for the detection of metallic substances in air involve direct counting such as for silica or asbestos, and chemical analysis for such toxic substances as lead, mercury and chromium. Microchemical methods have been developed due to the small quantities available, and lead is determined colorimetrically through the use of diphenyl carbazide or for minute quantities by the dithizone method. Chromium is determined colorimetrically by using s-diphenyl carbazide, and in strong HCl solutions as little as 1 p.p.m. may be detected.

Mercury, in the form of vapor, can be detected by the GE selenium sulphide detector. Rapid direct determination by the blackening of selenium sulphide test paper indicates as little as 1 part of mercury vapor per 4 million parts of air.

Some of the generally accepted threshold values for prolonged exposures to metals are:

Chromic acid	1.0 mg. per 10 cu.m.
Lead	1.5 mg. per 10 cu.m.
Mercury	1.0 to 2.0 mg. per 10 cu.m.
Zinc oxide fumes	150.0 mg. per 10 cu.m.

Alloys for Milk Containers

Tin and zinc added to the copper-nickel alloys used in the construction of dairy processing equipment have a tendency to inhibit the solubility of the copper and thus limit the development of oxidized flavor in the milk, experiments at the Davis Laboratories of the University of California have revealed.

In experiments conducted at Davis, a study was made of the corrosion of certain copper-nickel alloys in milk during the pasteurization process. The alloys studied contained from 62 to 66.5 per cent copper and 20 to 31 per cent nickel, with smaller amounts of tin, lead, zinc, chromium, iron and manganese added to some of them. The results showed that when from 3 to 8 per cent of tin and 3 to 4 per cent of zinc were included in the alloys, the corrosion rate in the milk is reduced and the development of oxidized flavor is delayed. The experiments were conducted by Dr. C. L. Roadhouse and J. L. Henderson of the dairy industry division of the University.

Method for Sealing Platinum to Pyrex Glass

A satisfactory seal between platinum and Pyrex glass, for use in the construction of chemical and other scientific apparatus, has been developed by Edward Wichers and C. P. Saylor of the Chemistry Division of the National Bureau of Standards, Washington, D. C.

The general problem of joining metals and glass has been studied by many investigators, but the fact that the thermal expansions of platinum and glass are so different has always caused trouble. Thus, when a platinum wire or rod is coated with hot glass, subsequent cooling will crack the glass or pull it loose from the metal. Wichers and Saylor have surmounted this difficulty by using a seamless tube of platinum instead of a wire or rod. If the walls of the tube are thin as compared with its length (say a ratio of 1 to 12), the shrinkage forces are not great enough to crack the glass internally or to pull the metal away from it. In the case of a platinum tube within a glass tube, the relative dimensions of the glass enclosing wall also affect the tension of the boundary. The lower limit for the ratio of diameter to wall-thickness of the glass for this type of seal is set by the resistance of the glass to failure by cracking of the entire wall.

Gallium Output of Germany

Germany's annual production of gallium now amounts to about 50 kilograms (110 lb.) and the price is about Rm. 10 ($4.00) per gram, according to Consul David H. Buffum, Leipsig. The metal, used as a backing for optical mirrors and in alloys for the dental profession, is being produced by the Vereinigten Chemischen Fabriken, at Leopoldshall, not far from the Mansfeld copper mines.

Supposed Brittleness of Tin at High Temperatures

It has been generally stated in the past that tin becomes brittle at about 200° C., so that it may be powdered in a mortar and this phenomenon has been explained by the transformation of the metal at this temperature into a brittle allotropic form: namely, gamma tin supposedly belonging to the rhombic crystal system, whereas the crystal form of ordinary tin is tetragonal. However, careful work has recently shown that this brittleness is due to the presence of minute metallic impurities. It has been shown that the actual brittle fracture of tin is caused by the incipient fusion around the grain boundaries of eutectics or solid solutions melting at a relatively low temperature. Since the grain boundaries thus consist of a thin film liquid alloy, the slightest stress could pull them apart. It is believed that the rhombic crystals formerly discovered in the smelting furnace were actually stannous sulphide rather than tin. Whereas lead, copper, silver and cadmium may cause brittleness, antimony, arsenic and iron do not appear to be contributory to hot brittleness.

Silver in Stainless Steel

A patent that has been recently granted claims to increase the possibility of the extent of the use of 18-8 stainless steel alloys for marine purposes. Small amounts of silver, it is claimed, in stainless steel will effect marked increases in the degree of corrosion against salt water. In addition small amounts of silver, for example, of 0.14% are stated to increase the thermal conductivity of stainless steel, as well as to improve the ease of machining and ability to take a high polish.

Post Scripts

It is difficult to concentrate on writing this column with Europe facing its blackest days since 1914. However, we mustn't let mental depressions create business depressions as did the hot-dog stand owner in Ohio who was doing a splendid business until his son came home from college full of learning and said, "Pop, haven't you heard there's a depression? The country's in the doghouse and what we need is etc." After Sonny got thru, Pop was really worried and said, "Gee, if there's a depression, I'll have to cut out advertising and reduce my overhead." Pop did and now he is in a depression.

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Final Briefs from Asbury Park

Jack Mayers of Frederic B. Stevens Co. had a good reason for arriving late at the convention. He attended his son John's graduation from Princeton University. John was a high ranking scholar in engineering and was awarded a Phi Beta Kappa key.

•

Jack Dimone of Pennsylvania Salt Co., *Dr. C. B. F. Young*, and *Joan Trumbour* rated awards of valor for being whirled by the professional skating team. Dr. Young was taken for a real ride.

•

An impromptu meeting of Sargent & Co. men of the past and present included *Jim Hines* (S 1908-1914) now with Patent Button Co., Waterbury; *Jim Puritan* (S 1895-1915) who was *Joe Sexton's* boss; *Joe Sexton* (S 1900-to date) who was the editor's boss; *Henry Creamer* (S 1909-1911) and yours truly (S 1929-1931). *Ted Eichstaedt* of Detroit, *Jim Reynolds* and *Johnny O'Connell* of Fitchburg, Mass. were the missing alumni.

•

George Klink, *Lionel Cinamon* and *George Hoganboom* sat near enough to the pretty dancers at the entertainment Thursday evening to get a good eyeful. Cinamon showed great interest in the "Pansies in the Spring" dance.

•

Homer Morton of Keeler Brass Co., Grand Rapids, Mich. saw the ocean for the first time at Asbury Park.

•

Honors for "Jitter-bugging" (if anybody would ever award honors for jitter-bugging) go to *Bob Jackson* of Philadelphia.

•

Bill Belke spent considerable time with his harmonica, probably practicing to join Borrah Minnevitch and His Rascals.

•

Some of the "old-timers" at the dance could wear down many of the youngsters. Included in this group were *Mr. & Mrs. Frank Hanlon*, Chicago (in fact *Austin Fletcher* couldn't stand the pace Mrs. Hanlon set), *Mr. & Mrs. Royal S. Clark*, *Mr. & Mrs. John Oberender* (New Haven), and *Burt Daw* (St. Louis) who complained about the dances being too long only because he didn't have time to dance with all the ladies.

•

Unsolved mysteries—(1) Who put the tip on *Dr. Kasper's* plate at dinner on Thursday night, and why? (2) Who put those meal charges on *Wilfred "Liquid Sulfur" McKeon's* hotel bill?

Finis

• •

Is Uncle Jim An Elk?

"Every one in our family is some kind of animal," said Jimmie to the amazed preacher.

"Why, you shouldn't say that!" the good man said.

"Well," said Jimmie, "mother's a dear, the baby is mother's little lamb, I'm the kid and dad's the goat."—Exchange.

Some New England platers relaxing over a horse-shoe game. Left to right—Don't know, Bob Mooney, Al Huber, Al Rosenthal, Joe Downes, Don't know, E. A. Sesselman, Don't know.

The Hot-Nosed Reporter's Impression of Detroit Branch's A. E. S. Picnic

The annual picnic of the Detroit Branch of the American Electroplaters' Society was held at the Sandy Mac's Golf Club Course, Saturday, August 5th.

The event was a high success being attended by over 200 members and friends of the local branch. Most of those attending enjoyed the golf which was free to everyone on the beautiful, sport 27 hole layout noted for its beautiful greens and glass-like fairways. Not many high scores were turned in as the course bears a reputation in the Detroit area as being one of the sportiest and toughest in this part of the country. Notable among the better golf scores was *William Phillips* of the General Motors Corporation with an 85 for the first nine; *Carl Heussner* just managed to beat Mr. Phillips with an 84 score—helped by several nudges in some of the cavernous traps. In as much as *Jim Higgins* threw away his card, no one can tell how he made out.

Supreme President *Ray Goodsell* and Executive Secy. *Bill Kennedy* were with us for the day and did the horse shoes fly through the air! They both won prizes—but not for pitching. The prizes must have been for working as Goodsell and Kennedy seemed to be among the busiest men present. It must have been serious business too, as they were always in a corner deep in discussion with *Phillips*, *Bill McCord* or somebody like that. In the evening at the Yacht Club, Kennedy took a drink. Don't get excited. It was only water. They both got away safely Sunday morning—we hope. We also hope they'll be back for our annual party, Dec. 9th.

Fred May of Electric Auto-Lite of Toledo, took a lesson from *Ed. Perry* of the Udylite Corp., *Cleve Nixon* of Ternstedt and *Paul Amundsen* of Parker-Wolverine decided to quit after three holes to give Cleve a chance to show the boys how to pitch horseshoes.

Jack Bunch of Cadillac was a threat in the horseshoe pitching contest all the way.

Al Payson of the Michigan Buff Company and *Joe Nook* of Kalamazoo, entered a contest for which there was no prize. They both shot the bar in par. *Jim Stewart* of L. A. Darling Company, a Bronson socialite, brought a bodyguard with him by the name of *J. Wallingford Humphrey*. He also brought two quarts of milk. How are your ulcers, Jim?

Phil Brockway of Ford Motors appeared in his usual sartorial splendor as a delegate from Esquire and walked off with the prize for being the best dressed man. *Chester Marshall* of Ainsworth won a prize in the Kitty-Kar race but next year, Chester says, he will try something a little easier on the legs.

Walter Pinner didn't help anybody's golf course by passing out advice and birdies through the loud speaker just when the boys were set to either tee off or putt.

Several father and son combinations were noticed on the grounds. *William M. Phillips Sr., & Jr.* seemed to be inseparable all day, they played golf, pitched horseshoes and played table tennis. By my observations, I would say that the *Jr.* is crowding *Sr.* in all the different sports and that it is a real Father and Son combination.

Other Father & Son combinations were *R. C. Mahoney* and *Son; Herbert Cross* and *Son;* and *Ernie Beightol* and *Son.*

Bill Kennedy, Ted Eichstaedt and Ray Goodsell talking it over at the Detroit picnic.

Austin B. Wilson who is a past president of the Supreme Society and at present Chairman of the research committee was quite active all day taking part in all the Sports and Contests. He and *Billy McCord, Paul Amundsen* and *Carl Kennedy* had Some Croquet Game. A tip to any one playing croquet with them is to surround the court with a high board fence.

Our president, *Jimmie Higgins* of the Packard Motor Car Co. was quite busy in assisting the committee although it did not interfere with his getting rid of his share of corn and other refreshments.

Floyd Oplinger of Dupont came all the way from Niagara Falls for this gathering and *Doug. MacDermid* came from Waterbury, Conn.

We missed the presence of *J. C. Robinson, Chas. Beaubien* and *Gus Soderberg.*

We wonder how *Paul Strausser* got home after eating so much, and also when.

Orchids and plenty of them to *Mose Cherry,* General Chairman of the picnic committee and his able assistants *"Red" Wilson, Charles Anger, Dick Saltonstall, Wright Wilson, Joe Hoefer* and *Walter Pinner.* Our space is limited and we cannot express full gratitude to all the donors of the fine prizes which helped to make the affair a success.

Your hot-nose reporter will now sign off with the hope that *Carl Heussner* either buys a pair of glasses so he can tell a ball from a strike, or some day will get enough Coca-Cola.

Respectively yours,
Hot-nosed Reporter.

•

In the July issue was published an account about a bogus subscription agent named Palmer. Three weeks ago *Sam Herrick* wrote the following Letter:

San Jose Plating Works
San Jose, California
July 26, 1939.

Metal Industry,
New York

Tom Trumbour

Dear Tom:

Outside of sending in my subscription I have not written to the *Metal Industry* since about 1916. But noting an article in July issue regarding a Palmer or McArthur, I had the pleasure (?) of a visit from him today. And reporting him to the police he was picked up within 1 hour. So he will possibly be unable to sell the *Metal Industry* for some time, he also tried to sell me the Iron Age, for which I would have no use in my business. There also was a call from Long Beach on him so he will no doubt, have to go there for a sojourn. Possibly he did not expect to run into an old timer in a town like this, but you never know who you will find in California. So Tom say "hello" to the boys back East and send me another July issue, the police have mine.

Sincerely yours,
Sam Herrick.

Fast and good work, Sam!

•

A Bouquet from Mr. Ozement

Dear Sirs:

Considering present and future standing concerning my own success, I have arrived to such a point as the needs be, I would like to make a purchase of some sheet carbon ranging from ¼" to ⅜" in thickness and approximately 7" sq. and in some cases even larger. I am under the impression and are pursuaded to believe, that due to fact that as you come into contact with various numbers of mfg. that you will abbundently be in position to address me of a number of mfg. of sheet carbon, of which of I would be grateful and pleased.

I am a subscriber of the METAL INDUSTRY and I find within many many things written that no electric plater could afford to miss or withdraw himself from lest he find out it was a mistake to to his own finicial loss and time.

Sincerily,
Henry R. Ozement,
Los Angeles, Calif.

•

"You say this woman shot her husband with this pistol, and at close range?" asked the coroner of the eye witness to the colored tragedy.

"Yassuh."

"Are there powder marks on his body?"

"Yassuh. Dass why she shot him."

•

Oscar Servis offers the following preamble to a satirical encyclopedia of fishing terminology: *Hail to the Mighty Fisherman*—"He ariseth early in the morning and disturbeth the whole household. Mighty are his preparations. He goeth forth full of hope. When the day is far spent, he returneth smelling of strong drink. And the truth is not in him." A few choice definitions follow:

Ye Angler's Dictionary of Revised Definitions of Fishing Terms

Fishing: A disease for which there is no cure; "Catching" but not contagious. It formerly infected only savages, small boys and village n'er-do-wells; but it now attacks presidents, judges, ministers, doctors, engineers, purchasing agents, and ten million others. In extreme cases, the fever can be reduced by placing the patient in the hot sun for several hours.

Fishing Camp: A place to wear out old clothes; shoot crap, eat half-cooked food; fight insects and act red-blooded. Liveliest hours are from midnight to daylight. Happy camping parties have been spoiled by erratic individuals who insisted on "going fishing." A favorite camp motto is "Fish and visitors smell after two days."

Bait: A secret word of the fishing fraternity for a highly exhilarating beverage, which is carried "on the hip." It will remove varnish and counteract heat, cold, snakebite, bad luck, "that tired feeling," or "what have you."

•

Profound Emotion Shown by Mrs. Polar I. Zation Upon Learning of her Election to Dave X. Clarin's Aunt Ella Society.

Dear David Xenophon (?) (your guess is as good as mine) Clarin:

I was never so overcome with emotion, (since my fourth husband changed his socks two years after our marriage) as I was today when the mailman brought my certificate of charter membership in your, or should I say our, Aunt Ella Society.

We Aunt Ella girls will be known the length and breadth of the land by our insouciance to our husbands zeal for fecund erudition, our eschewance of rancor for any *lucus a non lucendo's*—Gosh, Dave, I am so excited I've mixed my metaphors—what I meant to say is that we will be good sports if our "for better or for worse" neglects us for educational sessions or is somewhat incoherent in the "wee sma' hours."

May I propose a toast to the girls of the Aunt Ella Society:

Here's to the girls of Aunt Ella,
And to its founder who is a grand feller,
We will try every day,
In our most earnest way,
To make each convention still better.

Auntie Polar I. Zation.

Walter R. Meyer

Rinsing Costs Shrink Away In A "Vortexeddy" Spray

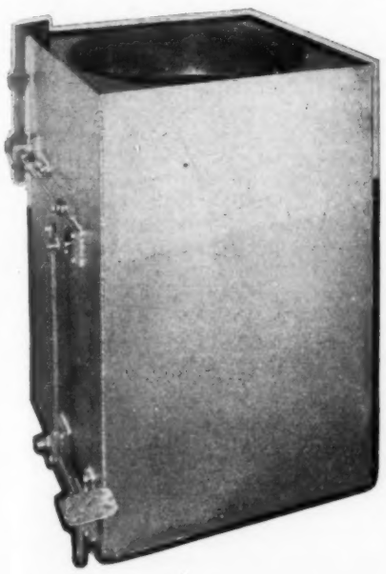
YOU CAN! - YOU WILL!

1. Save 38 to 86% on rinse water costs.
2. Shorten rinsing time up to 65%.
3. Produce cleaner rinsing effectiveness.
4. Reduce number of rinse tanks.
5. Eliminate contamination of acids and alkalis caused by drag or carry over.
6. Minimize spotting and staining of finished work.
7. Cut cleaner material costs by use of more effective detergents.
8. Decrease Sewage Piping Loads.

"Vortexeddy" is -- The Storts Way -- of Using Spray

It derives its name from the (patent applied for and pending) principle of breaking up horizontal counter-current vortexes of sprayed liquids with straight line cross current spray streams to create thousand-fold eddies of fine, dense spray, whirling and swirling in all directions, in a controlled and confined area.

THIS NEW, NOVEL AND PRACTICAL — TESTED, TRIED AND PROVEN function of effective spray action is now available for manually operated rinsing tank purposes in standard tank and coil form, in two types—one for foot pedal control and one for hand lever operation.



Both Types Are Illustrated And Described In Our

FREE BOOKLET

"Rinsing With Spray — The Storts Way"

Your request for a copy will not obligate you in any way -- WRITE FOR IT TODAY

STORTS WELDING COMPANY

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Manufacturers of High Quality Welded Fabrications to Specifications

NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

New Spray Rinse Tanks

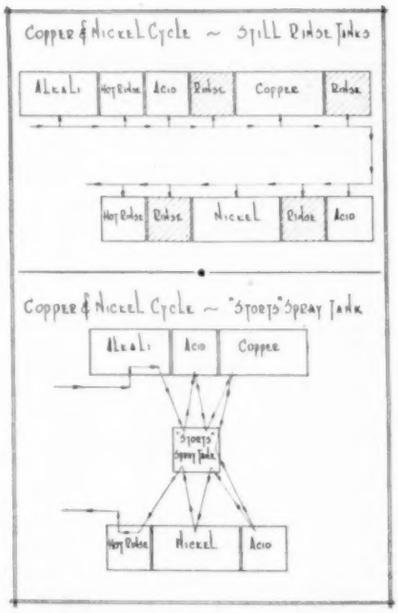
Storts Welding Co., 42 Stone St., Meriden, Conn., has announced the development, in a well illustrated booklet of new rinse tanks which are claimed to effect marked reductions in the cost of water for rinsing during plating cycles.

The standard sizes of rinse tanks are: 24″ x 24″ x 36″ deep with 21″ dia. top opening; 30″ x 30″ x 36″ deep with 27″ dia. top opening. Special sizes and other square or rectangular shapes can be furnished to order.

These rinse tanks are supplied with either a foot pedal control or with a hand lever. The use of these levers insures that the water is only used when the work is immersed in the tank and this feature alone is said to account for remarkable water economies.

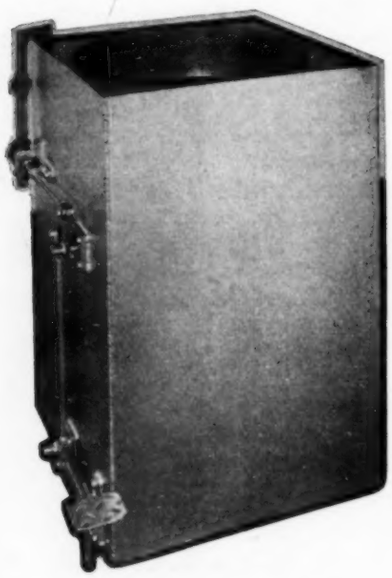
The tanks are made of Armco ingot iron, are double-welded and the inside area of the tank and all surfaces of the top opening cover are double coated with a resinous corrosion resisting material specially designed for this purpose. The tanks have adjustable hangers for parts and accessories are of aluminum, brass and cadmium plated steel.

Hand-lever type of spray rinse tank for general and special production use.



Cycles for copper and nickel plating without and with the spray rinser.

The special spray nozzles and the scientific arrangement of these nozzles are said to result in a spray of extreme fineness and density which insures rapid rinsing action with the minimum amount of water consumption. The vortex and eddy streams of water developed are said to accomplish rinsing in from 1 to 4 seconds.



Foot-pedal type of spray rinser.

The hand lever type is used by attaching the rack holding the work to a special adjustable holder and the lowering of the cover with the work automatically starts the rinsing. The foot pedal control is used without the cover arrangement.

In addition to the savings resulting from water economy other claimed savings result from:

Shorter rinsing time.

Fewer tanks required.

Less rejects due to thorough rinsing of cleaners and pickles.

No contamination of solutions by drag-over.

The use of more poorly rinsing but more efficient cleaning materials is made possible.

An illustrated booklet describing these tanks together with further information can be secured by writing to the Storts Welding Company.

New Rust Preventative

A new rust preventative called Metaseal has just been released to the trade by the Estox Products Company, 157 Brewery St., New Haven, Conn. The product has been the result of ten years of development in protecting steel against moisture and salt air. The chief use of the product at present is to protect steel parts against rusting during processing in the factory, or during storage before or after assembly.

Metaseal is applied as a thin solution. It can be applied by dipping, spraying, or brushing and the dried film is hardly discernible. The coating is easily removed even after months of storage. However, the coating has been found to possess priming qualities, according to the manufacturer, and therefore, in many cases the subsequent lacquer, enamel, or paint finish can be applied directly over the coating. It can also be used to protect plated and colored finishes. According to the manufacturer, Metaseal is valuable for protecting aluminum, brass and other metals in addition to steel. Due to the thinness of the solution and the high solids content, high coverage is claimed.

For further details write the Estox Products Co.

New Electric Cleaners

Magnus Chemical Co., Garwood, N. J., has announced the development of their new line of cleaners which are claimed to in-

volve a slightly different method of cleaning, utilizing a new type of cleaning agent.

This material is offered in a graded series of electroplaters' metal cleaners based upon the Magnus wetting agent, "Saponex." This unique material, it is said, has extremely rapid wetting, penetrating and dispersive power, thus providing more rapid and thorough cleaning. It is claimed to be acid and hard water-proof, and thus no trouble from scum can be formed by drag-over. It is also stated to be very free rinsing.

"Electrex" is reported to be particularly valuable for bright plating as it is claimed to eliminate any need for scouring. It is used at high concentration and high current density with reverse current, with all metals except zinc, aluminum or other soft metal which should be cleaned cathodically.

The manufacturers state that steel or copper surfaces can be cleaned in one electrocleaning operation, removing polishing or buffing compound, almost all drawing compounds, smut, finger-marks and shop dirt.

For further details, a technical bulletin may be obtained by writing to the manufacturers.

Hydrion Buffer Capsules

A new series of reference standards, known as "Hydrion" buffer standards, have been developed by Micro Essential Laboratories, Brooklyn, N. Y., for checking electrometric pH apparatus.

These capsules are distributed by R. P. Cargille, 118 Liberty Street, New York City.

The capsules are made up in powder form and are carefully standardized to give the following pH's when dissolved in the proper amount of water.

pH 3.0 ± 0.05
pH 4.0 ± 0.05
pH 6.4 ± 0.03
pH 7.38 ± 0.03
pH 9.2 ± 0.05

Each preparation is claimed to have been

Capsules for making pH reference standards.

carefully checked electrometrically with the hydrogen electrode at 25° C., and also by using as primary standards, pure compounds of established pH value.

These capsules are claimed to offer definite advantages in accuracy and time-saving for the checking of electrometric pH apparatus.

New Process for Metal Casting Using Rubber Molds

Alrose Chemical Company, Providence, R. I., has developed and standardized for the first time, a complete low cost process for producing white metal castings with rubber molds. Quality castings of fine detail and smooth texture can now be produced, it is claimed, without blow holes on a production basis. This new process is said to replace expensive bronze molds and produces from fifteen gross to one hundred gross of castings from a mold costing less than $5.

Models may be of any metal and do not require drafting; undercut items may be readily produced. The process makes duplication of any item possible within the space of a few hours, said to be invaluable in filling spot or rush orders. According to the manufacturers it also permits a large sample range at low cost. From one to seventy-two pieces may be cast simultaneously in one mold depending upon size. The entire process can be set up and operated in a space 60″ x 60″.

This new process should be of interest to all producers of white metal, tin alloy or lead castings, novelties and jewelry. Further information is available from Alrose Chemical Co.

Treatment for Zinc Coatings

Mar-Nel Chemicals, Redford Station, Detroit, Mich., have announced the development of a material, called "Galv-A-Niel," for the treating of zinc coatings to insure adherence of paints and other organic finishes. The material is sold as a concentrate and after being diluted with three parts of water, it is applied by brushing, spraying or dipping, and is said to effectively treat from 1200 to 2000 sq. ft. This treatment, it is reported, prepares the galvanized metal for painting, cleaning the metal of all ordinary dirt, oil, finger-marks, etc., as well as to build up a surface film which produces a perfect bond for the paint.

Such treatments are said to give long-time assurance against peeling and blistering of the paint as well as being a preventive against the spread of corrosion.

Literature and further details can be obtained by writing to the manufacturers.

One Coat, One Fire Porcelain Enamel Finish

The Porcelain Enamel & Mfg. Company, Eastern and Pemco Aves., Baltimore, Md., has announced the development of a new one coat, one fire brown porcelain enamel finish.

According to reports from the industry and verified in the laboratories, this new brown one coat, one fire finish means a saving in production costs. After drying, the brown coat may be grained in the bisque and fired at one time. It is said to be especially desirable where lighter gauge metals are used, as the firing temperature is much lower than that ordinarily maintained to obtain a good bond.

It covers uniformly and completely, it is claimed, and has a good glossy finish. In applying it over pickled ware, this coat is said to eliminate any minute imperfections which may be in the metal.

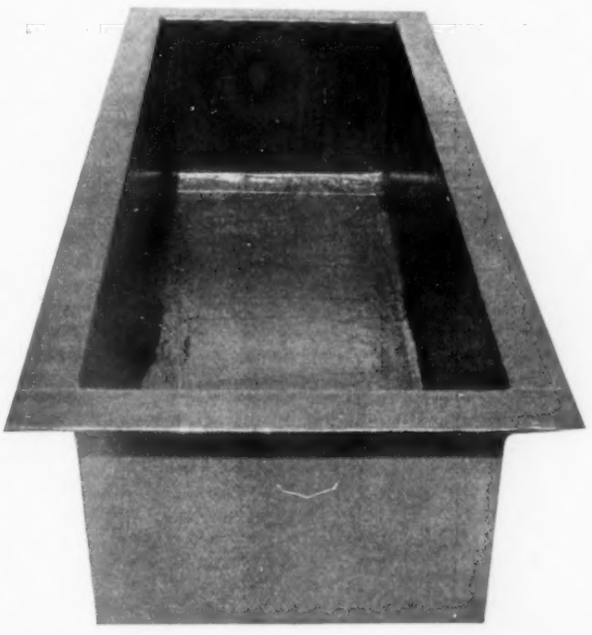
New Tank Lining

The United States Stoneware Company, Akron, Ohio, now has available a new synthetic tank lining material, "Tygon," which is recommended as being suitable for handling of any and all plating or pickling solutions.

The manufacturers claim that it is not affected by the strong oxidizing agents such as concentrated nitric, sulphuric, or chromic acids, aqua regia, etc. Tanks lined with this material have the added advantage of being able to handle first one solution and then another, making it unnecessary, it is said, to compromise pickling or plating solutions to those which the tanks will handle.

The coating is generally applied to steel, although it may be applied to concrete or wood tanks.

Literature is available on "Tygon," the latest development in 74 years of research on corrosion-resistant equipment by this company.



"Tygon" lined tank for pickling or plating solutions.

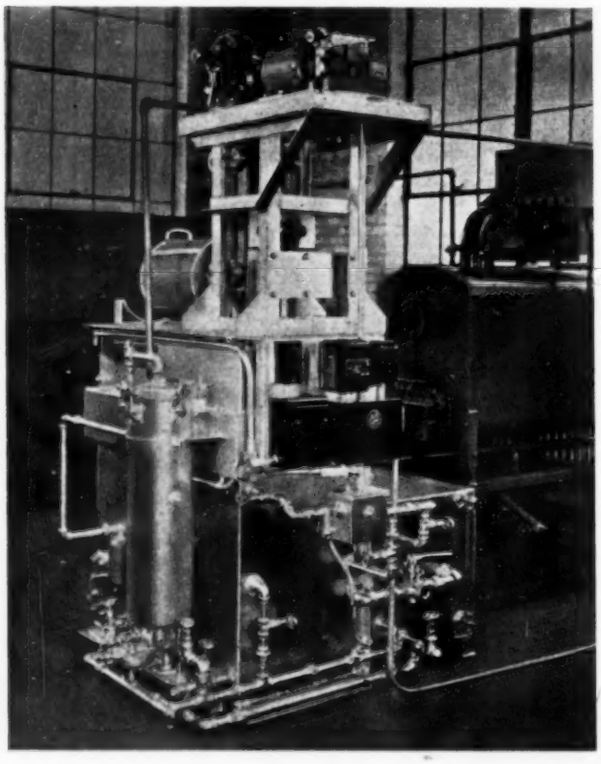
1-Dip Degreaser with Rotating Baskets

The Detroit Rex Products Company, 13005 Hillview Ave., Detroit, Mich., has developed and marketed a machine in which degreasing can be applied to cup-shaped work, effected through a rotating basket design.

This degreaser consists essentially of a one-dip or liquid-vapor design with storage tank and a special automatic elevator mechanism which raises and lowers the rotating baskets. A continuous filter at the side of machine, is used to keep the boiling chamber free of insoluble material, and a continuously operating solvent still is used to remove oil contamination. By this means the work is always immersed into clean solvent and a final pure-vapor cleaning action is given as the work is raised out of the boiling solution.

tion of the basket during its descending and ascending travel. A push-button station located adjacent to the loading end operates the elevator drive mechanism, while limit switches and a time interval control govern the travel of the elevator and basket. After the set time interval for cleaning in the boiling solution, the load returns automatically to the loading-unloading station.

This rotating-basket design of degreaser is manufactured in various sizes ranging in capacity up to two tons per hour to suit individual requirements. The unit shown herewith has the following overall dimensions: length, 4′; width, 4′ 8″; height, 7′ 2″. The operating height to center line of basket spindle is 4′ 8″. The rotating baskets are 12″ diameter by 15″ long. The



Rotating basket type of one-dip degreaser for cleaning cup-shaped objects with low solvent loss.

A clean solvent storage tank is located at the rear side of degreaser. The elevator drive mechanism is shown on a platform above the structural work (hood shields have been removed from the upper structural work in order to show details of elevator mechanism and the rotating basket for holding the work). The elevator drive is effected by a combination right-angle-geared-head motor and brake, complete with a reversing switch, vacuum tube time relay, limit switch and push button station.

Electrical controls, water separator and vapor trap are located on end of machine opposite the loading-unloading station. The boiling compartment has a removable clean-out door and drain valve, and is equipped with a steam jacketed bottom and steam pressure relief valve.

The drum-shaped mesh basket with which this machine is equipped for rotating and draining the work, fits over a spindle which is attached to the elevator mechanism and has a gear and pinion device to cause rota-

solvent capacity of the boiling chamber is 61 gallons, and the storage tank is of sufficient size to hold all of the solvent from the machine. The approximate weight is 1,600 pounds, not including accessory equipment and solvent still.

Outstanding economies are claimed in the cleaning of cup-shaped work by this rotating basket design, and the work, it is said, comes from the degreaser clean, warm and dry—free from the last trace of solvent vapors, chips and abrasive. Engineering balance of heat input against production, together with high capacity water jacket condenser and other features, which maintain the vapor line at the mid-point of the condenser, are reported to be further cleaning economies.

Respirator for Metal Fumes

Willson Products, Inc., 267 Thorn St., Reading, Pa., announce the first and only Bureau of Mines Approved Type B Mechanical-Filter Respirator for protection against fumes of metals.

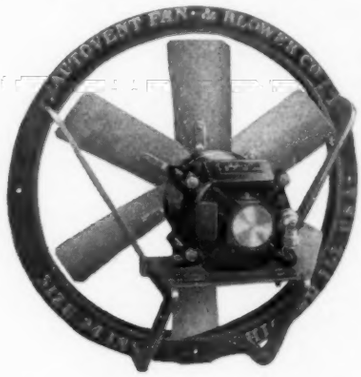
This new product, designated as Willson Respirator No. 770, bears Bureau of Mines Approval No. 2128 "for protection against fumes of metals such as lead, mercury (except mercury vapor), manganese, magnesium, aluminum, antimony, arsenic, copper, chromium, iron, cadmium and zinc resulting from sublimation or the condensation of their vapor, or from chemical reactions between their vapors and gases."

The manufacturer will be pleased to forward descriptive literature and prices upon request.

Fans with Protective Heresite Coatings

The Autovent Fan & Blower Company, Chicago, Illinois, announce a new treatment on their acid-moisture proof and vapor-explosion proof propeller fans.

This new chemical coating is known as Heresite and is especially recommended for use on fan wheels where extremely corrosive and highly concentrated acid or gas fume



conditions prevail. The fan wheels are given multiple coats of Heresite baked finish at a temperature of 375°F. Extensive tests by the company prove that this patented treatment keeps severest acid and practically all metal corroding substances from destroying the metal to which it is applied. Where acid-moisture proof fans are required, Heresite coated fan wheels are of heavy gauge steel, powered by fully enclosed round body motors that provide positive winding protection against all fumes and moisture. For installations where acid and fume conditions are less severe, the fan wheels are treated with three coats of Bakelite lacquer. The vapor-explosion proof units have fan wheels of copper, brass, or other non-ferrous metals and motors bearing Underwriters Label, Class 1, Group D rating. Non-ferrous fan wheels used on vapor-explosion proof fans can also be treated with Heresite where severe corrosive fumes are handled. Special construction features of motor meet the specifications approved by the National Board of Fire Underwriters. Centripetal fan wheel construction, no churning of air and non-overloading power characteristic, feature these units.

Autovent has prepared a bulletin describing Heresite treated fans. Anyone interested in learning more about this new development may obtain a copy upon request.

Brighteners, Brittle Deposits and Peeling

By Leslie L. Linick

Linick, Green and Reed, Inc.
Chicago, Ill.

Many a plater who has tried one or more of the brighteners or addition agents, which have been recommended, has been delighted at first with the results obtained but later may have lost interest when certain disadvantages arose, which far outweighed the benefits received.

In general, with the use of brighteners, higher current densities can be used. A powerful brightening agent reduces the size of the crystals being deposited; in many cases to such an extent that these crystals can no longer be resolved by the microscope, and X-ray diffraction is necessary to determine the ultimate crystal structure. The current densities which would ordinarily produce rough, large crystals and in some cases burning, will plate a bright homogeneous coating in the presence of certain brighteners.

Often, however, changes in current density may require some apparently minor but important modifications in plating procedure or else brittle deposits with inevitable cracking, striations, peeling or blistering may result. While some brighteners cause hairline cracks or geographic plating under any conditions, most of the modern addition agents require only simple adjustments or omissions in the plating bath to obviate these conditions. Brittleness may be induced by an excess of ammonium, potassium or sodium compounds or carbonates, the effects of which become very pronounced with the use of greater amperage. The obvious remedy is the reduction in concentration of these compounds. Excess carbonates in cyanide solutions which may be formed, for example, by overheating of the bath, may be precipitated by cooling or by the use of a specially purified calcium sulphate.

In regard to electrocleaners, these materials should be kept free from the salts of heavy metals, inasmuch as these metals may be deposited out on the work as a smut which will eventually result in non-adherence of the plate. These smuts may be removed by reversal of the current in cleaning and by a subsequent acid or cyanide dip.

Peeling can also be traced frequently to momentary immersion of the article into the plating bath without the current being on. Whether the trouble is due to the surface of the article going into the solution, the deposition of foreign matter in the bath upon the work, or of simple immersion plating, is beside the question. The fact is that it is advantageous to have the article and electrical contact so made that immersion closes the circuit. This procedure will also help to prevent surface oxidation in acid baths and scum occlusion or discoloration in alkaline solutions.

The peeling effects of chromic acid, for example, in alkaline plating baths, such as copper or zinc, may be overcome by having the current on at the moment of immersion of the steel articles into the plating bath.

The manufacurers of "Tantol" brightener call attention to the difference between brittleness and toughness of electrodeposits—in fact, these terms have opposite meanings and a brittle coating, of course, lacks toughness. By the use of glue, mucilage, dextrine or gum as brighteners, most metal plates reach their ultimate in brightness and at the same time show a minimum of toughness. On the contrary, some of the modern brighteners increase the toughness and with proper solution control show no semblance of embrittlement. In certain cases and under definite conditions, the addition of only a very small amount of a brightener may have a noticeable, unexpected and very often an entirely unpredictable effect on the crystal structure of the deposit. For example, 3 parts per million of an organic derivative of the metallic element tantalum, 7 parts per million of antimony, 4 parts per ten thousand of lead in the presence of carbonate, or of soft solder even slightly dissolved under similar circumstances, will have a very noticeable effect in various plating baths.

New Sealing Material for Rubber-Lined Tanks

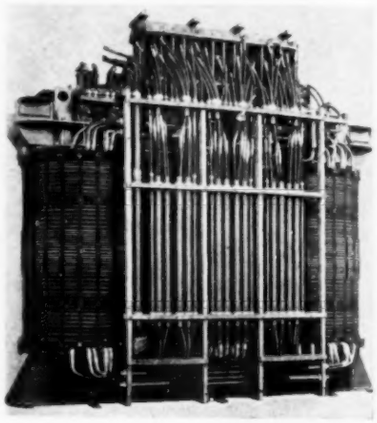
The modern plating industry has generally adopted rubber as an efficient lining for tanks to carry plating solutions. However, rubber-lined tanks have been observed to undergo plating-over of the lining by stray currents. In addition due perhaps to porosity or perforations in the coating, blisters may have developed by the penetration of moisture through the coating to the metal with the creation of gas formed by the corrosive action of the solution on the metal. This action may be accelerated by wetting agents in the solution.

Paramount Rubber Service, Inc., 1430 Rosedale Court, Detroit, Michigan, have announced the development of a sealing process by the use of Impervium, which it is claimed, effectively prevents any of the above-described difficulties due to porosity. Impervium is claimed to be resistant to oils, acids, alkalis, and other deteriorating agents and also shows a very high dielectric value as high as 3000 volts per mil. In addition to obviating the porosity, Imperivum sealer prevents attack on the rubber lining by oils or other chemicals and the sealer coating is easily kept clean since all deposits of salts used in the plating solutions are easily washed off. The company states that one of the largest plating tanks in the world for bright nickel plating was recently treated with Impervium sealer. The manufacturer also states that the cost of seamless rubber-lined tanks with the Impervium sealer is of the same order as plain sheet rubber-lined tanks.

For further details write Paramount Rubber Service.

Six Million Silver Brazed Joints Without a Failure

A production record recently released by the General Electric Company tells of a remarkable service they are getting from low temperature brazing alloys in constructing transformers. More than six million copper to copper joints have been made in the last few years and to date there has not been a single field failure. These joints are mainly between taps and coil conductors and between copper bars. Incandescent carbon heating is used principally in making them and the alloy, which is a silver, copper, phosphorus composition, manufactured by Hardy & Harman, New York City is preplaced in strip form between the parts joined or, in some joints, is fed in from a rod by hand. Numerous tests have been made to determine the electrical conductivity of this type of joint. Lap joints show less resistance than the copper itself, while butt joints show a very slight amount more resistance. The transformer shown includes more than 400 joints brazed with silver alloys.



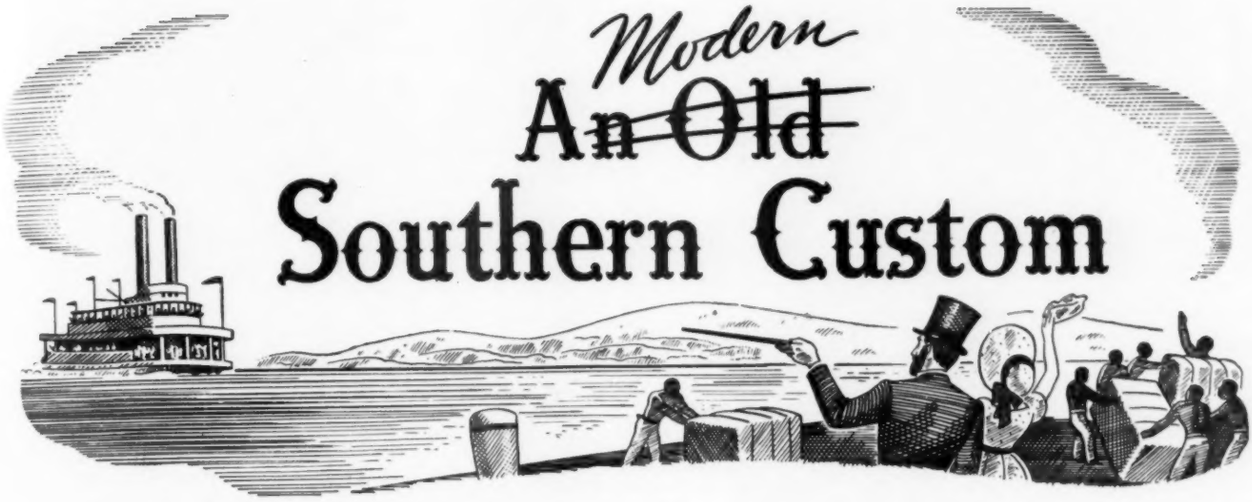
This 40,000 KVA Transformer has more than 400 Sil-Fos brazed joints.

Manufacturers' Literature

Abrasives. Sixth edition of general catalog, revised, on coated abrasive papers and cloths, including price list for these papers and cloths for metal working, wood working and leather working. Abrasive Products, Inc., South Braintree, Mass.

Buffing Lathes. A folder covering variable speed lathes of Chas. F. L'Hommedieu & Sons Co., 4521 Ogden Ave., Chicago, Ill., which claims to make a saving, accomplished by increasing the speed to maintain the peripheral speed of the buff when it was at its original size, by turning a hand wheel, which would increase the speed to that required.

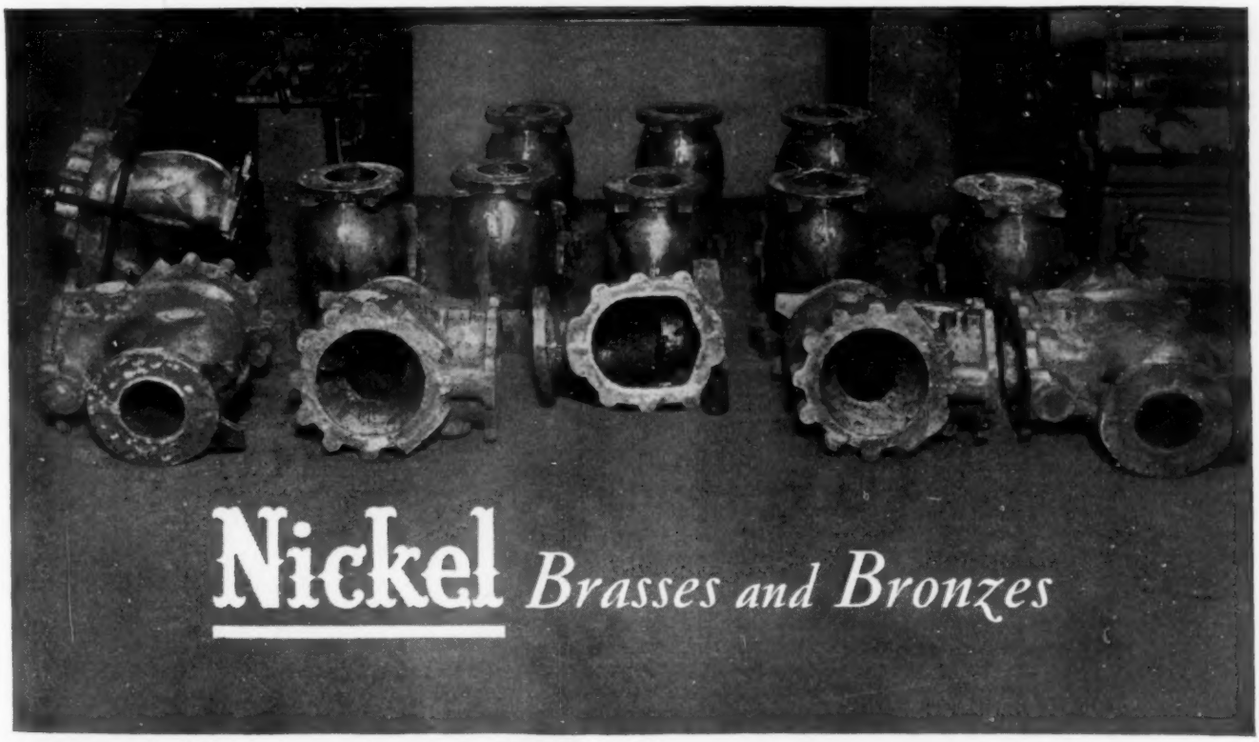
Belt Data. A new engineering data book for machine designers and engineers designing V-belt drives. It is divided into two parts, the first part covering standard



Modern ~~An Old~~ Southern Custom

Nowadays progressive foundrymen rely upon Nickel to minimize shrinkage porosity and refine the grain of castings which must be pressure tight. Down in New Orleans, the F. H. Koretke Brass and Mfg. Co., cast these 6″ water meter valves to withstand 225 lbs. pressure per square inch. Koretke uses an 88-10-2 "G" bronze mixture, modified by 1½% Nickel. • By replacing 3½% tin in this bronze composition with an equal amount of Nickel, similar castings will withstand more than 3,000 lbs. pressure per square inch. • The practical observation of many foundrymen has firmly established the fact that Nickel improves metal fluidity which aids in filling all parts of the mold and reduces rejections. By promoting a dense close-grained structure, Nickel assures pressure tightness of brass and bronze castings. • Improved pressure-tightness is but one of many money saving advantages Nickel offers you men who cast and use brass and bronze. Please write for more detailed information about money-saving applications of Nickel.

Water meter valve bodies weighing 275 lbs. each, cast by the F. H. Koretke Brass & Mfg. Co., New Orleans. Their "G" bronze composition was alloyed with 1½% Nickel.



THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK, N. Y.

drives eliminating the necessity of working out calculations, and the second, sheave factors for designing new or special drives. The book also contains belt comparison tables and other general information. The Manhattan Rubber Mfg. Division, Raybestos-Manhattan, Inc., Passaic, N. J.

Cadmium. A folder describing the preparation and use of "Cadalyte" bright dip in cadmium plating, listing the following advantages: a high brightening efficiency; negligible thickness of metal removed; no stripping of thinly plated parts; quick and free rinsing; a dilute water-white solution; permits nickel plating or other deposits over the bright dipped deposit. E. I. duPont de Nemours & Co., Inc., Electroplating Division, Wilmington, Dela.

Chemicals. "Baker's Analyzed" C. P. chemicals and acids, (also other laboratory and technical chemicals) are covered in this catalog, containing solutions, volumetric standards, conversion tables with weights and measures, and international atomic weights—1938. J. T. Baker Chemical Co., Phillipsburg, N. J.

Cleaner. A folder describing Resistex an alkaline cleaner designed for cleaning bright nickel or buffed nickel previous to chromium plating. MacDermid, Inc., Waterbury, Conn.

Cleaners. A folder containing illustrations which show where "Wyandotte" cleaner is used—in restaurants at the World's Fair and elsewhere, factories, dairies, etc. J. B. Ford Co., Wyandotte, Mich.

Coating. A folder on "Ceil-Por" a translucent amber-colored coating, which is reported to seal pores on any surface, has a tough elastic film, and resists most all chemicals and acids as well as heat, moisture, abrasion, etc. The Ceilcote Company, Rockefeller Bldg., Cleveland, Ohio.

Foundry Riddles. "Buffalo" foundry riddles are described in a folder issued by Buffalo Wire Works Co., Inc., 308 Terrace, Buffalo, N. Y. These include steel riddles (2-14 mesh); galvanized riddles (2-8 mesh); brass riddles (2-14 mesh).

Furnaces. Principles of operation, types of high frequency supply generator operated heaters, speed of heating, heater construction, converter operated heaters, and low frequency inductive heating are the subjects covered in Bulletin 13 on "Ajax-Northrup" electric furnaces. Ajax Electrothermic Corp., Div. Ajax Metal Co., Trenton, N. J.

Gear Generator. Bulletin 442 contains helpful information for executives and engineers of plants using or making gears. It describes the latest type of "Farrel-Sykes" gear generator for generating gears up to 25" diameter, and explains the advantages the machine offers for high speed production of precision herringbone gears and other types of gears used for connecting parallel axes. Farrel-Birmingham Co., Inc., 344 Vulcan St., Buffalo, N. Y.

Heaters. Bulletin 3195. How to heat electroplating baths with G-E immersion heaters. The following information is given in this bulletin: what heat does; how much heat to use; information on electric heating equipment including catalog numbers, prices and discounts; how to determine current requirements, and automatic temperature-control equipment. General Electric Co., Schenectady, N. Y.

Illium. Bulletin 103, which contains general information on Illium, a corrosion resistant alloy. It is reported that as a result of continued experimental work during the past several years, the utility of this alloy has been enhanced by the development of presses for fabrication into strip, tubing and rolled stock. Burgess-Parr Company, Freeport, Ill.

Nickel Alloys. "Tremendous Trifles" is the title of a new booklet issued by the International Nickel Company, 67 Wall St., New York City, containing a collection of practical ideas used by electrical equipment manufacturers for solving, it is recorded, some major problems with small parts of nickel, Monel, "K" Monel and "Z" Monel.

Nickel Alloys. A folder on typical nickel alloy steels and cast irons employed in Diesel engine construction. The International Nickel Co., 67 Wall St., New York City.

Rectifiers. Bulletin ER-102 gives the principles of copper-oxide rectification, construction of the complete rectifier, operating characteristics, applications and advantages, and testimonials. Hanson-Van Winkle-Munning Co., Matawan, N. J.

Rinsing. A booklet offering two types of spray tanks—the foot-pedal type for general production use, and the hand-lever type for general and special production use. These tanks are standardized in two sizes for racked parts rinsing, not basket or bulk rinsing. Both types can also be furnished to any square or rectangular—length, width and depth, with various dimensions of round or oval tap openings to suit rack and work dimensions and other requirements. Storts Welding Co., 42 Stone St., Meriden, Conn.

Tank Linings. A folder illustrating "Ace" rubber lined plating tanks in various plants, which claim to provide protection against the effects of wetting agents in bright nickel solutions. American Hard Rubber Co., 11 Mercer St., New York City.

Telemetering Device. Bulletin No. 194-A is now available. It presents a simple electrical mechanism which is said to accurately transmit and indicate, record or integrate the measure of any factor, such as flow, level, pressure and temperature at a distant point. The bulletin points out that metering equipment operated on this principle claims to have accuracies equivalent to mechanically operated metering equipment, that the device actually operates as a torque amplifier which does not send any reaction back to the transmitter; and that the system is not affected by any ordinary variations in voltage or power factor. Wiring diagrams illustrating the principle of operation are included. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.

Tin. "Tin and Its Uses," July 1939, No. 2, contains the following chapters: Tin Research in America; Electrodeposited Tin Coatings; New Alloy for Condenser Tubes; Statistical Year Book 1939; Hot Tinning, and Canned Foods in the British Empire. The International Tin Research and Development Council, 149 Broadway, New York City.

Waterproofing Materials. A catalog devoted to "Wurtzilite" waterproofing and roof coatings, which the manufacturers report can be applied on vertical surfaces, and after evaporation of solvent, will not flow or sag or show loss of adhesion under hottest climatic conditions, nor embrittlement at zero temperatures. Shingle-Gibb Co., 54th & Gray's Ave., Philadelphia, Pa.

Zinc Coating. A folder recommending "Galv-A-Niel" for new and old galvanized metal as well as for zinc die castings and any other metal containing a large percentage of zinc metal, to assure adhesion of the paint film. Mar-Nel Chemicals, Redford Sta., Detroit, Mich.

Rectifiers for Electroplating and Electrotyping

Bulletin ER-102, issued by the Hanson-Van Winkle-Munning Co., Matawan, N. J., manufacturers of electroplating equipment and supplies, is the first complete detailed treatise on this new type of equipment for producing low-voltage, direct current for electrodeposition. It describes the principles of copper-oxide rectification, the construction of the complete rectifier, its operating characteristics, its applications and advantages. A few representative testimonials are given from users of rectifiers.

The Bulletin is profusely illustrated by means of electrotypes made with H-VW-M copper-oxide plate-type rectifiers.

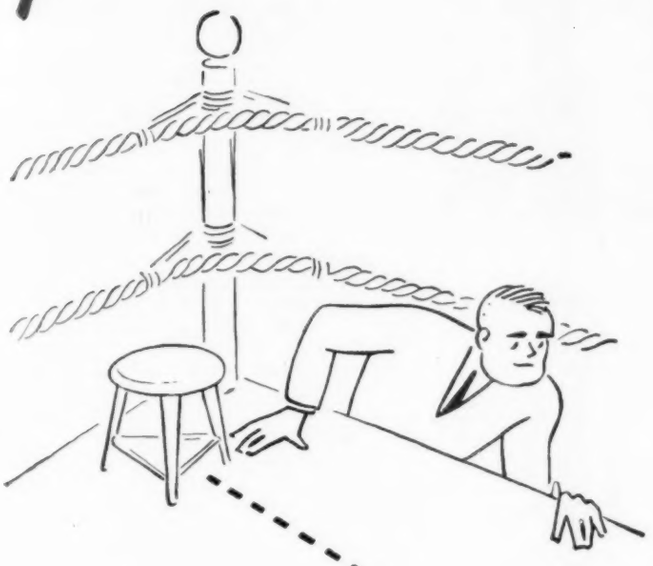
Seamless Rubber Coverings

Belke Manufacturing Co., 947 N. Cicero Ave., Chicago, Illinois, has announced a new seamless rubber covering for coating tanks, fans and all acid handling equipment. The equipment is lined in the Belke Factory and perfect adhesion is claimed for the coating to metal. Steam vulcanization is used for vulcanizing the coatings and, it is claimed, results in strong durable and acid resistant coverings.

Because of the absence of seams, it is stated that these coatings obviate difficulties of the solution penetrating between the seams and opening them.

For further details write Belke Manufacturing Co.

Your Seat-a Ringside Seat!



Forty-four leaders and co-leaders are busy planning the sixteen clinics that will answer 200 problems uppermost in the minds of industrial advertisers.

Here are a few of the subjects:

Extra-curricula activities
Selling advertising to the sales force
Performance data and photographs
How to sell the management
Direct mail for the industrial advertiser
Making exhibits profitable
How to determine readership values
Publicity—how to prepare it
Market information—how to get it

OTHER EVENTS YOU WON'T WANT TO MISS

IDENTICAL INTEREST LUNCHEONS
TRADE SHOWS—EXHIBITS—AWARDS
PUBLISHERS' RECEPTION—DINNER—SHOW
N.I.A.A. DAY AT THE WORLD'S FAIR

•

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•

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Letters From Our Readers

Mr. Hothersall Sends His Greetings

Cunard White Star "Ascania"
July 31, 1939

Dr. Walter Meyer, Editor,
Metal Industry, N. Y.

Dear Sir:

Your generously worded message to me in the editorial column of the July issue of your periodical gives me the welcome opportunity of writing to express my sincere appreciation of the very cordial reception accorded to me by you, by the American Electroplaters' Society and by numerous individuals. I shall carry back with me to England many pleasant memories of America and of Americans, and I hope that further opportunities may soon arise to consolidate the friendships which I have been privileged to make during my visit.

If, in addition to personal experiences, my visit has helped to promote closer contact between the two electroplaters' technical societies—the American Electroplaters' Society and the Electrodepositors' Technical Society of London, England—I shall feel that it has been doubly useful.

Yours truly,
Arthur W. Hothersall.

On Pore-Free Silver Electrodeposits

American Silver Producers' Research Project
National Bureau of Standards
Washington, D. C.

August 8, 1939.

Dear Dr. Meyer:

I would like to clarify an erroneous impression that might result from reading the abstract of our paper "A Study of Silver Plating for Industrial Applications" that appears in *Metal Industry*, July 1939, page 330.

According to this abstract "at present time 0.001″ seems to be the minimum thickness of silver that can be plated without porosity." Actually our conclusion reads as follows:

"1. Pore-free deposits of either silver or copper 0.001″ thick on deep drawing steel are readily obtainable.

2. On a suitable basis metal, such as electroplated or polished oxygen-free copper, pore-free silver deposits 0.0001″ thick can be produced."

The minimum thickness of silver that can be plated without porosity depends greatly upon the surface quality and composition of the basis metal. I would like to correct any impression that 0.001″ is the minimum thickness that can be plated without porosity under any condition.

You should have received a copy of our ninth progress report, dated July 1, on page 3 of which mention is made regarding nonporous coatings on the order of 0.0001″ in thickness. Such thin coatings are not deposited direct on steel.

Very truly yours,
A. J. Dornblatt.

The effects of the basis metal on the porosity of silver electrodeposits are truly striking and these findings have a correlation in the work of Hothersall and others that

the porosity of nickel electrodeposits is strongly influenced by the condition of the basis metal.

The widespread use of silver deposits in place of tin, for example, for cans, will depend on the development of pore-free deposits of sufficient thinness to compensate for, to a large extent, the higher cost of the metal itself. The importance of Dr. Dornblatt's correction is therefore, obvious.—Editor.

Wrong Normality of Iron Chloride

U. S. Department of Commerce
National Bureau of Standards
Washington, D. C.

August 14, 1939.

Dear Dr. Meyer:

I am writing to call your attention to a minor error in the article on iron plating by J. B. Kushner in the August number. On page 395 he gives the formula of the solution as "0.5 *N* $FeCl_3$." This should be "5.0 *N* $FeCl_3$," which corresponds to 67 oz./gal. The error is probably too small to warrant a specific correction and my only reason for calling your attention to it is to emphasize the difficulty (which I fully appreciate) of checking every numerical value in these publications. With best wishes.

Sincerely yours,
W. Blum, Chemist.

Dr. Blum charitably calls the slip of a decimal point, minor. It is about as minor as paying 50c. for something costing $5.00. Thank you, Dr. Blum, for the sharp eyes.—Editor.

On pH Papers

Aug. 14, 1939

Dear Dr. Meyer:

I wish to compliment your magazine upon the interesting article on "The Measurement and Control of pH" published in your June and July numbers. As this short, but comprehensive survey of pH testing methods, is destined to serve as a convenient guide to the plating industry, I would like to make a few comments regarding pH papers, the latest method for testing pH values.

It seems to me the authors arrived at an erroneous conclusion regarding the relative costs of pH tests by various methods. They take only into consideration the cost of material consumed in testing, whereas modern cost accounting would include three factors:

1. Cost or value of labor or time
2. Cost of material consumed
3. Depreciation, breakage and repairs.

Assuming that a test can be made in 10 minutes with a potentiometer, in 5 minutes with a comparator, and in ½ minute with pH papers and figuring the cost or value of time at 2 cents per minute (a low estimate since not only the remuneration actually paid, but overhead, etc. would have to be included) we arrive at the following approximate figures:

	Potentiometer		*Comparator*		*pH Papers*	
Value of time	(10 min.)	20 c.	(5 min.)	10 c.	(½ min.)	1c.
Material consumed		½c.		½c.		3c.
Depreciation, etc.		1 c.		1 c.		0c.
Cost per test		21½c.		11½c.		4c.

It would, therefore, appear that where intermittent tests are being made frequently, pH papers are much more economical than the other methods; in fact the saving would be quite considerable, whereas where tests are only made once in a while, the factor of cost would hardly get much consideration. Where time has no value at all, the other methods would be cheaper but pH papers would be more convenient.

No investment for apparatus is required in the case of pH papers. More than one potentiometer or comparator set would be needed in larger plants in order to make more than one test at a time, but one box of pH papers would suffice for a good many tests taken simultaneously.

These conclusions are also amply borne out by the experience of other industries where pH papers are used in processes requiring many and frequent tests.

In regard to bright nickel solutions, I have so far not received any intimation from clients using pH papers for the testing of bright nickel solutions that they found it difficult to get readings on account of deep coloring. However, the opinion of an authority on this subject will command more attention. Mr. Gustaf Soderberg of The Udylite Corporation, who in turn control the Bright Nickel Corporation, wrote me recently, "I find that we do not have any difficulty in our laboratory in testing bright nickel on account of opacity or deep color. For accurate estimation we view the paper by transmitted light just as you suggest. We feel that from the standpoint of getting reproducible readings the pH papers are very satisfactory."

I believe that both the authors of your interesting article, as well as your readers, will be interested in these factual statements.

Very truly yours,
Paul Frank.

Mr. Hall's Reply

August 18, 1939.

Dr. Walter Meyer,
Metal Industry,
116 John Street,
New York City.
Dear Sir:

Thank you for your letter of the 15th together with the copy of Mr. Paul Frank's letter.

I'm afraid that I must take issue with Mr. Frank on some of his points in favor of the test papers. Neglecting the potentiometric pH tests which, of course, would not be employed where the simpler methods are satisfactory, I think that his comparisons between the comparator and pH paper are rather optimistic.

In the first place, he assumes that a test will take 5 min. with a comparator as against ½ minute with the paper. In our laboratory work we figure about 1½ minutes for the test, but to check this I had myself timed with a stopwatch. To open the comparator set, fill the tubes with solution, add indicator, shake, match colors, rinse the tubes and close the set the time required was 55 seconds and I did not hurry. Of course, due to constant practice I know approximately what the pH is as soon as I add the indicator and therefore do not have to change the standard tubes more than once, but I believe that this can be expected of any man who is checking the pH of a solution regularly.

Mr. Frank next assumes a pay rate of 2c/min. or $1.20/hr. for the fellow who makes the test. I believe that this rate is rather high for a plater since the more common rate would be about 90c/hr. In any case, using Mr. Frank's argument that where intermittent tests are being made frequently, the papers are more economical because of the high labor charge, I would like to point out that a 60c/hr. helper can do the job just as well. After all it is not customary to have a high priced man do the job which can be done by a cheaper man. I therefore would state that the labor cost would be 1½c for the comparator as against ½c for the paper.

We both agree on the cost of material per test but I next take issue with his depreciation figures of 1c per test. Since a $5.00 set of standard color tubes is guaranteed against deterioration for 5 years, and the life of the box is practically indefinite, I think a total depreciation and breakage cost, allowing $1.00 per year for the latter, should not be more than $10.00 for a 5-year period. Even using a figure of 4 tests per day the depreciation and breakage cost per test would only be about 0.2c per test. If the point is raised that breakage is greater than $1.00 per year, my refutation would be that this would indicate more usage than 4 tests per day and the depreciation per test would be lowered correspondingly.

By these philosophical deductions, in the manner of Tristram Shandy's father, I arrive at a total cost per test of 2.2c for the comparator as against 3.5c for the test paper.

With regard to Mr. Frank's last contention in connection with bright nickel solutions, I cannot find any statement in our article that pH paper might not be satisfactory for this application. We recognize the fact that in highly colored or turbid solutions comparator sets are often unsuitable and we refer to page 318 in the July issue of *Metal Industry*, where you will note our statement that in turbid solutions indicators are not satisfactory and the potentiometric method *or pH paper must be used*. We have found, however, that in many cases the color of the test strip is not the same as the standard color bar when using pH paper, unless the user has a good imagination. Mr. Frank quotes Mr. Soderberg as saying that the papers are *very satisfactory* for bright nickel. However, I am still to be convinced that they are *as satisfactory* as a comparator even neglecting the matter of cost, especially in view of the closer control possible with the color sets which are read within 0.1 units.

Sincerely yours,
Nate Hall.

August 22, 1939.

Metal Industry,
New York City.
Dear Dr. Meyer:

If Mr. Hall can make a test in one minute with a comparator I think he is doing considerably better than the average. In most of the larger plants it would take already that long to take a sample. However, I do not wish to argue that point, since it can best be left to the individual plating shop, and I am quite satisfied if the value of labor or time is being recognized as part of the total cost of a test.

Mr. Hall seems to be reluctant to accept my figure of 2 cents per minute as a reasonable one for the cost of labor, because some platers are being paid less. I tried, however, to point out in my previous letter that 2 cents per minute ($1.20 per hour) is not meant to be the remuneration *actually paid*, but would include overhead that has to be figured. I feel sure that my figure errs on the conservative side, if at all.

I remain
Yours very truly,
Paul Frank.

Costs for labor should also include overhead and Mr. Frank's figure of 100% overhead is not high.—Ed.

New Books

Rapid Quantitative Electrolytic Analysis and Separation of Metals. By George W. Slomin. Published by E. H. Sargent & Co., 155 E. Superior St., Chicago, Ill. Size 11" x 8½"; 27 pages. Price 75c.

This book contains an up-to-date discussion of electroanalytical methods. Some of the chapters are: Outline of Electrochemical Determinations; Addition Agents; Electro-Separation of Elements by Applying Graded Potentials; Electrode Design and Current Efficiency; Care of the Electrodes; Applications of the Slomin Electrolytic Analyzer to the Electroplating Industry. Most of the reliable methods for the foundry analysis of alloys, electroplating solutions and electrodeposits are presented in this volume. Methods are given for determining aluminum, antimony, beryllium, bismuth, chlorine, chromium, gold, indium, iodine, iron, lead, magnesium, mercury, nickel, palladium, platinum, rhodium, silver, tellurium, thallium, tin, titanium, uranium, vanadium and zinc.

Lead Bronze Bearings. Original German edition published Nov. 1938 as "Bleibronzen als Lagerwerkstoffe" by the Deutsches Kupfer-Institut E.V., Berlin, Germany. English edition translated and published by the Copper Development Association, Thames House, Millbank, London, S. W. 1, England. Size 8½" x 6"; 46 pages. Copy can be obtained, free of charge, from Copper Development Association, address given above, by making application on firm's letter-head.

This beautifully illustrated and printed little book on lead bronze bearings summarizes the present state of knowledge on this subject.

The book discusses the Theory of Bearings; Running-in and Emergency Properties; Anti-Friction Properties and Load Capacity; Strength of Bearing Metals; Structure of Copper-Lead Alloys; Influence of Third Elements; Melting and Casting Technique; Casting on Shells; Sintered Lead-Bronze Bearings; Design of Bearings; Machining and Erection; Further Developments.

Lead bronzes have acquired increased importance since the war, both in Germany and elsewhere, and steel backed copper-lead bearings may today be regarded as one of the best materials for withstanding exacting load contents, such as are encountered in airplane and light Diesel engines. The book should be of value not only to those who are interested in lead-bronze bearings themselves, but to the student of any type of bearing.

Herstellung Hochwertiger Metallueberzuege (Production of High Quality Metal Coatings). By Walter Eckardt and Oskar Kramer. Published by Eugen G. Leuze, Leipzig S 3, Germany. Size 8¼" x 6"; 142 pages. Price $2.00.

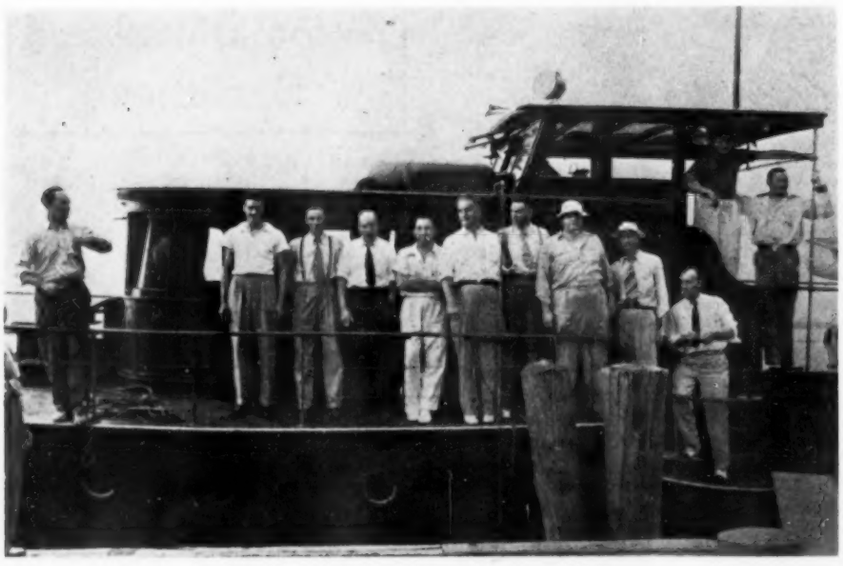
The author has endeavored to prepare a reference book and handbook which gives a complete discussion of the causes for errors in electroplating, as well as the removal of these errors or troubles. The scientific work on electroplating by numerous technicians in the field has been collected and put into a practical, easily understood form. Some of the chapters are: The Influence of Hydrogen on the Properties of Metals; The Influence of Impurities; The Protective Value of Electrodeposited Coatings; Etching, Bright Dipping, Electrolytic Etching; Anode Reactions—Corrosion; Cleaning; followed by chapters on zinc, copper, brass, silver, lead, tin, rhodium, platinum, gold, cadmium, iron, nickel and chromium plating. The book also contains chapters which discuss: Formation of Protective Coatings by Diffusion; The Testing of Electrodeposits; The Analysis of Plating Solutions, and a rather extended discussion on troubles and means of avoiding these troubles in electroplating baths. The appendix contains useful physical data on compounds used in plating and tables for analytical calculations.

Associations and Societies

Electrochemists at New York

The Seventy-sixth Meeting of the Electrochemical Society will be opened at the Hotel Commodore, Monday morning, September 11, 1939, and will continue through Wednesday evening, September 13, 1939. As usual, the scientific-technical program is crowded with papers of both special and general interest.

The session Monday morning will be in charge of *Professor Hiram S. Lukens* of the University of Pennsylvania, and will be devoted to "Modern Methods in Electroanalysis." Experts in the field will discuss how, with the aid of the electric current, accurate analyses can be carried out in a few minutes, as against hours consumed in ordinary chemical analysis. The Tuesday morning session on "Corrosion" is in charge



Members of the Plating and Rustproofing Association of Michigan aboard the "Steechan."

Those aboard the ship are, from left to right: Ted Williams of Chicago; J. R. McQueen (Knight Plating Company); Charles H. Nehls (Wayne Metalcraft Corporation); Percy L. Stapleton (Service Plating Company); Glenn Friedt (United Platers, Inc.); Charles Erdman (Central Plating Company); George O. Hansen (Law Associate of the Secretary); Frederick R. Bolton (Secretary); W. B. Knight (Knight Plating Company); Robert L. Reed (Reed Plating Company); and on the bridge deck: The Skipper, Captain Quennell and H. E. Adelsperger (President of the Association).

of *Dr. Robert B. Mears* of the Aluminum Company of America. No other subject is of more general and vital interest to both scientists and engineers. Twelve papers will be presented covering the latest findings of the foremost research laboratories of the world: National Bureau of Standards, Cambridge University Laboratories of England, Separator Laboratories of Stockholm, besides laboratories located in Vienna, Berlin, Prague, Princeton, Pittsburgh, and Philadelphia. As a general rule the corrosion or rusting of metals is due to an electrochemical reaction. The Wednesday morning session will cover electrochemical subjects of a general nature including the electrometallurgy of lead, silver, nickel, manganese and arsenic. A paper which has attracted much attention in this country is one on the cadmium-nickel storage battery.

Social Functions

Monday, September 11, has been set aside by the New York World's Fair authorities as Electrochemical Day. In the afternoon *Professor Bradley Stoughton* of Lehigh University will give a popular illustrated address on *Modern Marvels of Electrometallurgy*. The meeting will be held in the Science and Education Building at the World's Fair Grounds and will be open to the public. Tuesday evening is the Edward Goodrich Acheson Medal Dinner at the Hotel Commodore. The Acheson Medal and $1000 Prize will be bestowed upon *Dr. Francis Cowles Frary*, Director of the Research Laboratories of the Aluminum Company of America. Following the dinner and medal ceremonies there will be dancing.

Plating and Rustproofing Association of Michigan

The Association held its first annual summer stag party on Wednesday, July 26, aboard the yacht, "Steechan."

The yacht left Detroit right after noon and sailed across Lake St. Clair and up to the city of Algonac, then turned around and came back a few miles to the Club Aloha, where members and guests were able to shake off their sea legs and enjoy a dinner.

Many members of the Association and

guests attended with visitors from as far south as Toledo.

The photograph shows some of the men who were present on the cruise.

American Electroplaters' Society

Bridgeport Branch

Annual Outing

Saturday, September 9, 1939

Eichner's Grove, Trumbull

Come one, Come all!

Buffet Lunch begins at 12.

The Barbecue Chicken Dinner DeLuxe goes on at 4:30 P.M.

Bring the Ladies.

Refreshments all day.

Games.

Prizes.

The Bridgeport Branch soft ball team challenges the New Haven team for the outing game. (Ringers from other branches are permitted to play.)

Directions from Bridgeport posted at the end of East Main St., at Beardsley Park, at the end of Noble Avenue.

Gentlemen $2.50. Ladies $2.00.

Eugene Phillips, *Secretary.*

Newark Branch

The Newark Branch will hold its Annual Outing on September 30th at Vogel's Grove, Union, N. J. Vogel's Grove is situated as follows: from Newark take No. 29 Highway to Springfield Road which lies about ½ mile from the "Flagship"; turn right on Springfield Road about ½ mile; turn left into Vogel's Grove.

The menu is as follows: celery, radishes, hot dogs, sausages, clams, steamed and on the half shell, hamburgers, corn, beer and soft drinks.

Admission: adults $2.00; children $1.00. 12 noon to 8 P.M.

Members of other branches and their guests are welcome.

George Wagner, *Secretary.*

Detroit Branch

Side Lights of Picnic Held at Sandy Mac's Saturday, August 5, 1939

The fourth annual outing of the Detroit Branch was, as usual, a high success in every way. The weather seemed to have been made especially for the occasion, sunny and warm with just enough breeze but not windy. Everyone who attended enjoyed themselves immensely. There were many out-of-town people present. Among them were our Supreme President, *Ray Goodsell* of Racine, Wis., and the Supreme Executive Secretary, *W. J. R. Kennedy,* of Springfield, Mass. Also some members of Toledo, Grand Rapids, Cleveland and Buffalo branches were present.

The attendance was approximately 225 with 25 coming from the Society's branches outside Detroit. *Mose Cherry* and his committee, *J. Hoefer, Dr. Saltonstall, W. L. Pinner, Chas. Anger, Ed. Berry* and their able assistants planned the entertainment and contests, leaving no dull moments throughout the day. The program consisted of golf and horseshoes in the morning; lunch from 1 P.M. to 2:30 P.M.; games to 5 P.M., consisting of Kiddy Kar relay races, cigar smoking contest, Governors special pop drinking, egg throwing and last but not least, the annual baseball game between the platers and their strippers. As to the baseball score, the least said the better. However, both teams agreed that the umpires won the game, and so they walked off with the prizes for the winning team. The lunch consisted of the usual sweet corn, hot dogs, cold cuts and other refreshments. Just seeing the big kettle of hot sweet corn was enough to insure everybody getting in line several times for extra helpings.

The prizes for the winners of the various events, and the drawing for the door prizes were the last things on the program which kept the interest of those attending, for there were approximately 30 prizes given as awards and 20 gifts drawn as door prizes. All these gifts and prizes came from supply houses, and plating firms who cooperated 100% towards making the picnic a success.

Wright W. Wilson, *Secretary.*

American Foundrymen's Association to Hold 1940 Convention and Exhibition in Chicago

The Board of Directors of the American Foundrymen's Association at its recent meeting accepted the invitation from Chicago, strongly supported by the Chicago Chapter, A.F.A., to hold its 1940 Convention in this city, May 6 to 10, inclusive. In conjunction with the Convention there will be a Major Exhibit of Foundry Equipment and Supplies in the exhibit halls of the International Amphitheater of the Union Stock Yards and Transit Company. This will be the first exhibition of the Association since the one held in Cleveland in 1938, and the first Major Exhibit in Chicago since 1914.

Fall Term of The Institute of Electrochemistry and Metallurgy to Begin Sept. 19

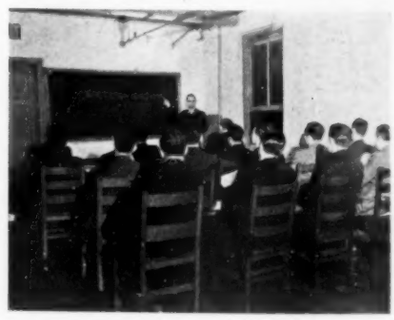
The Institute of Electrochemistry and Metallurgy, 59-61 East Fourth Street, New York City, will offer the following courses in electroplating, metallurgy and microscopy during the coming school year: Electroplating I, Electroplating II, Metallurgy I, Metallurgy II, Research I, Research II, and Industrial Microscopy I. All the above courses were offered by the Institute last year except Microscopy I. The trustees have added this course to the curriculum because of its importance to industry.

The registration dates for the Fall term will be September 11-15 inclusive. The first class will be held September 19 at 7:00 P.M. Last year the facilities of the Institute were taxed beyond capacity and students had to be turned away. A large enrollment is expected this year also. Under this condition early registration is advisable. Further information can be obtained by writing the Institute or calling Dr. Young at ORchard 4-1778 or FLushing 9-1685.

Descriptions of the Courses follow:

ELECTROPLATING I will consist of a study of chemistry. The course is designed to give the electroplater or industrial worker a foundation in chemistry including qualitative and quantitative analysis. One hour of each evening will be devoted to class lectures in which will be discussed the theories of modern chemistry as applied to electrometallurgy. The three remaining hours will be devoted to the laboratory where the student will conduct his own experiments. This class will be conducted each Tuesday and Wednesday from 7-11 P.M.—Fall term; Dr. Young and Mr. Klinsevich.

ELECTROPLATING II is designed to give the electroplater a knowledge of the ways and means of obtaining better deposits by applying the latest scientific methods of electrochemistry to electroplating. One hour of each evening will be devoted to a lecture on the theoretical aspects of the subject and three hours will be spent in the laboratory where the student will apply the principles set forth in the lecture. Copper, nickel, zinc, cadmium, chromium, silver, and brass will be deposited from aqueous solutions. While plating the above-named metals, the factors governing the character of the deposit, such as current density, temperature, pH, etc. will be noted. Other experiments will include throwing power, single electrode potential, addition agents, resistance of solutions, anodizing and coloring aluminum, corrosion tests, etc. After these are complete, the student will prepare standard solutions and make analyses of all the important constituents of the above plating baths. Tuesday and Wednesday, 7-11 P.M.—Spring term. Pre-requisite: Electroplating I or its equivalent. Dr. Young and Mr. Klinsevich.



Dr. Young lecturing to an Institute class.

In METALLURGY I the student will be introduced to the structure of metals and alloys and factors are taken into account which affect these, such as temperature, mechanical working, etc. The application of the phase rule to physical metallurgy will be discussed. Both binary and tertiary systems will be studied and illustrated. Heat treating, surface treating and testing of metals and alloys will be studied. Wednesday, 8-9 P.M.—Fall term. Dr. Young and Mr. Sherman.

METALLURGY II (Metallography) is designed to teach the student the preparation of metallographic samples for microscopic examination. The student will prepare several samples of various metals and alloys, etch and then examine them under the microscope. He will be taught to detect faulty alloys and metals by such examinations. Both ferrous and non-ferrous metal will be analyzed. Wednesday, 7-11 P.M.—Spring term. Pre-requisite: Metallurgy I. Dr. Young and Mr. Sherman.

RESEARCH I is designed to give the practical electrochemist a chance to investigate problems in his field. One-half hour per week is devoted to a conference with the instructor in which the method of attack is laid out. The remaining time is spent in the laboratory where the student applies the knowledge and technique to the solving of problems which arise in such an investigation. Tuesday and Wednesday, 7-11 P.M.—Fall term. Dr. Young.

RESEARCH II is the same as Research I except this is given in the Spring term. Dr. Young.

INDUSTRIAL MICROSCOPY I is specially planned in photomicrographical analysis, general microscopy, and instruction on the metallographic microscope. Subjects covered include the preparation of material and the proper selection of optical equipment, methods of illumination, control of glare, illumination by incident light, and

A class in metallurgical microscopy.

the use of color filters, special methods of particle-size determination, determination of refractive index, micrometry, and the proper use of mounting media with respect to its relative refractive index. Work with the polarizing microscope may also be arranged. —Spring and Fall term. Mr. Shillaber. Hours to be arranged.

Obituaries

Joseph V. Banks

Joseph V. Banks, vice-president of the Reed & Prince Mfg. Co., Worcester, Mass., and manager of that company's Chicago office and warehouse, died of heart disease on June 6th.

Harry Snyder

Harry Snyder passed away on July 20th. He was a member of Rossberg and Snyder, Inc., electroplaters and metal finishers. This firm at one time refinished all Pullman car silver service and many of the large bank doors, grilles and guards were finished at this plant. Mr. Snyder was a very earnest and diligent worker, giving valuable assistance to members of the platers' class at Jules Mastbaum Vocational School evening classes.

In 1912, he was elected active member of the Philadelphia Branch of the A.E.S., and served on various committees, being chairman of several committees, and was a member of the Board of Managers; also president of the Philadelphia Branch.

Mr. Snyder is survived by his wife, two sons and four daughters.

Alfred L. Sampson

Alfred L. Sampson, for 39 years shop superintendent of the General Electric Co., Lynn, Mass., plant, died on June 8 at his summer home in West Alton, N. H. Mr. Sampson was 75 years old and had been retired for a number of years.

Wallace Forest MacGregor

Wallace Forest MacGregor, director and chief engineer, J. I. Case Co., Racine, Wisc., died recently after an illness of three months, aged 65 years. Mr. MacGregor was a leading farm implement engineer, and had much to do with the development of modern threshers, combines and other farm machinery. At one time he served as president of the American Society of Agricultural Engineers, and at his death, was a member of the ASME.

Personals

Norman Chester has recently become president of the newly established organization, Rome Machinery Sales and Engineering Co., 627 Webster St., Rome, N. Y., which will design, manufacture and sell a complete line of modern polishing and buffing machinery and allied equipment.

Mr. Chester was born in Philadelphia, Pa., in 1898 and has resided in central New York for the past 38 years. He was associated with Divine Bros. Co., Utica, N. Y., from 1917 to 1939, first as assistant superintendent in their buff and polishing wheel manufacturing department, and upon inauguration of

Norman Chester

their machinery division, assumed charge of all design, with entire supervision over their manufacture, installation and service together with sales engineering work. This work included several of the largest installations of automatic polishing and buffing machine equipment for finishing automobile bumper bars and various other automotive parts in the history of the motor business.

Mr. Chester's hobbies are breeding thoroughbred Jersey cattle, hunting and fishing.

Joseph B. Kushner, B.S.Ch.E., who for the past five years has been associated with the electroplating and metal finishing industry in the capacities of practical plater, research electrochemist and engineer, has opened a consulting chemical laboratory for the trade at 20 Eldridge St., New York City.

Mr. Kushner is a graduate of the day school of the Cooper Union Institute of Technology and is well known for his many published papers in *Metal Industry* and other technical journals on electroplating subjects.

Ralph M. Neumann has been appointed general sales manager and *Arthur E. Mervine* assistant general sales manager of the New Jersey Zinc Co. and the New Jersey Zinc Sales Co., 160 Front St., New York City. Mr. Neumann will also continue as manager of the Pigment Division of the New Jersey Zinc Sales Co. Mr. Mervine will continue as manager of the Metal Division of the New Jersey Zinc Sales Co.

Richard P. Brown was recently appointed by Governor Arthur H. James to be the first secretary of the new Department of Commerce of the Commonwealth of Pennsylvania. Mr. Brown is chairman of the board of the Brown Instrument Company and vice-president of Minneapolis-Honeywell Regulator Company. He has been interested for some years in the industrial development of Pennsylvania, with the objective of increasing the number of jobs in private industry and thereby reducing the relief load and in turn the taxes necessary to support those on relief.

E. M. Cohan, President, Cohan-Epner Co., Inc., contract electroplaters and finishers, 142 W. 14th St., New York, has returned from a three months vacation in Miami Beach, Fla. Mr. Cohan will resume charge of production for the company, which is one of the largest of its kind, specializing in gold, silver and other precious metal plating for the jewelry and novelty trades. One of their leading specialties is metallizing, the deposition of metals on non-metallic objects such as plastics, glass, etc. One of their most interesting recent jobs was the plating of huge quantities of sea horses for costume ornaments.

G. K. Dreher, Ampco Metal, Inc., Milwauke, Wisc., has been elected chairman of the Milwaukee chapter, American Society for Metals to succeed *Prof. J. E. Schoen,* Marquette University. *Prof. J. F. Oesterle,* University of Wisconsin, has been named vice-president and *E. G. Guenther,* secretary-treasurer.

Carroll H. Henkel, metallurgist and chemical engineer, has recently joined the research staff of Battelle Memorial Institute, Columbus, Ohio, and has been assigned to the non-ferrous metallurgy division. He will be engaged largely in problems related to tin and its uses.

Mr. Henkel has had wide experience in pickling and tinning problems, both of a developmental and industrial nature. He was formerly metallurgist with the Carnegie-Illinois Steel Corporation and previous to that was chemical engineer in the research laboratory of the American Sheet and Tin Plate Company.

VERIFIED BUSINESS ITEMS

Vega Airplane Co., 1627 Victory Pl., Burbank, Calif., has begun erection of a one-story assembling unit. Cost over $70,000 with equipment. The following departments are operated: stamping, welding, grinding, sandblasting, polishing, cleaning, plating, anodic treatment, lacquering and finishing. The principal base metal used is aluminum.

The Rome Machinery Sales and Engineering Co., Webster St., Rome, N. Y., announces the establishment of an organization to promote the design, manufacture and sale of a complete line of modern polishing and buffing machinery and allied equipment. *Norman Chester*, formerly with a nationally known metal finishing equipment manufacturer for the past twenty-three years, will assume the management of this concern in the promotion of an efficient service to the metal finishing trade.

Zophar Mills, Inc. of Brooklyn, N. Y. announce the appointment of *H. P. Norden* as a sales representative of their Chemical Specialties Division.

Mr. Norden is well known throughout the industrial cleaning field in the Metropolitan area.

Charles L. Anger has joined the sales staff of the Hanson-Van Winkle-Munning Co., Matawan, N. J., manufacturers of electroplating equipment and supplies. He will be located in their Detroit office, 2842 W. Grand Blvd.

Carl F. Miller & Co., Inc., 1033—6th Ave. South, Seattle, Wash., have been appointed distributors for the State of Washington, for the Hanson-Van Winkle-Munning Co., Matawan, N. J., manufacturers of electroplating equipment and supplies.

The Lea Manufacturing Company, Waterbury, Conn., has made an arrangement with United Chromium, Inc., for the use of "Unichrome" rack coating-W to insulate plating racks. This material is said to be a new and improved rack coating which has been developed by *United Chromium, Inc.* The Lea Manufacturing Company has had several years experience in insulating plating racks for manufacturers, and has a special department fully equipped for dipping, drying and immersion of plating racks. They are in a position to give prompt and efficient service to manufacturers, especially in New England and New York State.

Bastian-Blessing Co., Grand Haven, Mich., soda fountains, store fixtures and equipment, plans one-story addition, totalling about 35,000 sq. ft. of floor space. Cost close to $55,000 with equipment. Departments: stamping, soldering, brazing, welding and buffing. Principal base metal used is steel.

The Metallizing Company of America, Inc., Los Angeles, Calif., has recently opened a sales and service office at 602 Academy Bldg., 17 Academy St., Newark, N. J., with *William McMakin* in charge. Complete parts on Mogul metallizer guns are available for prompt shipment, as well as metallizing wire. Free engineering service concerning metallizing problems is also available.

G. S. Crane, Vice President in Charge of Sales and Engineering for Cutler-Hammer, Inc., has just announced the appointment of *F. A. Wright* as Manager of Resale Sales with location at the Company's headquarters in Milwaukee. In his new capacity Mr. Wright will occupy the position formerly held by *B. M. Horter* who was recently appointed General Sales Manager.

Automotive Standard Products Corporation, has leased 8000 sq. ft. of floor space at 3717 N. Palmer St., Milwaukee, Wisc., for the manufacture of light automobile accessories. The company recently moved to Milwaukee. Departments: stamping, soldering, lacquering, enameling and finishing. Principal base metals used: brass, steel and bronze.

John A. Bauer, who has been for several years in charge of the New York office of the Hanson-Van Winkle-Munning Co. of Matawan, N. J., manufacturers of electroplating equipment and supplies, has been transferred to Matawan, N. J. to assist *L. M. Hague*, Vice President in charge of sales. *Irving A. Gemmell* has been taken from the Engineering Department at Matawan and placed in the New York office.

The designation metallurgically clean which has been copyrighted by *Mac Dermid, Inc.*, Waterbury, Connecticut denotes a surface in which all metallurgical products resulting from the disintegration of the metal surface are removed as well as the chemical contaminating impurities such as oils, greases, etc.

A metallurgically clean surface would be one, therefore, which contains no loose, poorly adherent, conductive particles such as iron, dust, graphite or carbon.

Frank W. Rock, formerly with the International Silver Co. and R. Wallace & Sons Mfg. Co., is now connected with *Roberts Rouge Co.*, Bridgeport, Conn. in the capacity of salesman.

The Seventeenth Exposition of Chemical Industries will be held at Grand Central Palace, N. Y., December 4 to 9, 1939. This Exposition may exceed all of its predecessors in size and scope according to advance indications of exhibitor response. Principal sections of the Exposition are chemicals and chemical products, laboratory equipment and supplies, instruments of precision, materials handling equipment, brewing, distilling and bottling equipment, containers and packaging machinery, industrial chemical equipment and machines. *Charles F. Roth*, President of the International Exposition Company is director, and has been similarly responsible for all of the preceding expositions dating back to the time when the first one was organized in 1915.

Oakite Products, Inc., 22 Thames St., New York City, will exhibit two new materials at the Machine Tool Show in Cleveland, to be held October 4-13. One of these is a material specifically designed for cleaning polished steel and buffed copper, and is said will effect cleaning and the complete removal of carbonized smut in one operation. The other material is a new type of soluble oil.

pH Papers A U. S. patent has been granted July 25 to the inventor. A number of foreign patents has been issued previously. pH Papers are marketed by Paul Frank, 456 Fourth Ave., New York City.

Zophar Mills, Inc. of Brooklyn, N. Y. announces the appointment of *E. J. Hinterleitner* of Westfield, N. J., as a district manager and service engineer of its Chemical Specialties Division.

Mr. Hinterleitner, who will make his headquarters in Westfield, N. J., is well known to industry throughout the United States and was formerly connected with the research laboratories of the United Chromium, Inc., of N. Y., the Harshaw Chemical Co. in Cleveland, and for some time conducted special research work at Columbia University under the direction of Professor Colin G. Fink.

Mr. Hinterleitner is perhaps better known as a "trouble shooter" on difficult problems in the industrial cleaning field and has developed many chemical specialties for that field.

List of Exhibitors at Machine Tool Show Cleveland Auditorium October 4-13, 1939

The following companies who manufacture or sell articles for the plating and finishing industry will exhibit at the Machine Tool Show at Cleveland:

American Felt Co., New York, N. Y.
The Black & Decker Mfg. Co., Towson, Md.
G. S. Blakeslee & Co., Chicago, Ill.
The Bristol Co., Waterbury, Conn.
The Bullard Co., Bridgeport, Conn.
The Carborundum Co., Niagara Falls, N. Y.
Cutler-Hammer, Inc., Milwaukee, Wisc.
Gardner Machine Co., Beloit, Wisc.
General Electric Co., Schenectady, N. Y.
The International Nickel Co., Inc., New York, N. Y.
Norton Co., Worcester, Mass.
Oakite Products, Inc., New York, N. Y.
Pratt & Whitney, Div. Niles-Bement-Pond Co., Hartford, Conn.
Wilson Mechanical Instrument Co., Inc., New York, N. Y.

A Resume of Indium Plating

(*Concluded from page* 421)

In a recent investigation of indium plating, Raub[11], notes these facts: Indium, co-deposited with silver does not produce tarnish-free alloys unless present in excess. Deposits from cyanide, chloride or sulfate solutions are rather dull. The plate cannot be buffed as buffing takes most of the metal off (remember how soft it is). An alloy formed by depositing indium over silver and heat treating in a hydrogen atmosphere is non-corroding but it is dull and remains so in spite of buffing.

This seems to be the present status of indium plating. There is no doubt the metal may have possibilities; if not by itself, at least in the direction of alloy plating, and it is up to the plater to find them out.

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Supply Prices, August 29, 1939

Anodes

Prices, except silver, are per lb. f.o.b., shipping point, based on purchases of 2,000 lbs. or more, and subject to changes due to fluctuating metal markets.

COPPER: Cast ..... 20¼c. per lb.
Electrolytic, full size, 14⅞c.; cut to size 15⅛c. per lb.
Rolled oval, straight, 15⅜c.; curved .... 16⅝c. per lb.
BRASS: Cast ..... 17 c. per lb.
ZINC: Cast ..... 9½c. per lb.

NICKEL: 90-92%, 16" and over ..... .45 per lb.
95-97%, 16" " " ..... .46 per lb.
99%+cast, 16" and over, 47c.; rolled, depolarized, 16" and over, 48c.
SILVER: Rolled silver anodes .999 fine were quoted from 49c. per Troy ounce upward, depending on quantity.

Chemicals

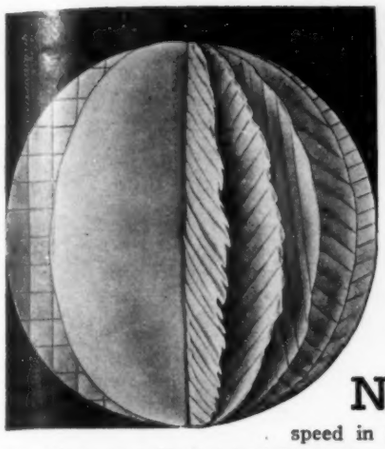
These are manufacturers' quantity prices and based on delivery from New York City.

Acetone, C.P. l.c.l., drums	lb.	.06¼
Acid, Boric (boracic) granular, 99.5%, bbls.	lb.	.053-.059
Chromic, 99%, 100 lb. and 400 lb. drums	lb.	.16¾-.17¼
Hydrochloric (muriatic) Tech., 20°, carboys	lb.	.027
Hydrochloric, C.P., 20°, carboys	lb.	.08
Hydrofluoric, 30%, bbls.	lb.	.07-.08
Nitric, 36°, carboys	lb.	.06
Nitric, 42°, carboys	lb.	.075
Oleic (Red Oil), distilled, drums	lb.	.08⅜
Oxalic, bbls. l.c.l.	lb.	.12-.14
Stearic, double pressed, distilled, bags	lb.	.10½-.11½
single pressed, distilled, bags	lb.	.10-.11
triple pressed, distilled, bags	lb.	.13¼-.14¼
Sulphuric, 66°, carboys	lb.	.025
Alcohol, Amyl, l.c.l., drums	lb.	.15-.165
Butyl-normal, l.c.l., drums	lb.	.085
Denatured, S.D. No. 1, 190 pf., bbls., works	gal.	.305-.315
Diacetone, pure, drums, l.c.l.	lb.	.095
Methyl, (Methanol), 95%, drums, l.c.l.	gal.	.385
Propyl-Iso, 99%, l.c.l., drums	gal.	.41
Propyl-Normal, drums	gal.	.70
Alum, ammonia, granular, bbls., works	lb.	.0315
Potash, granular, bbls., works	lb.	.034-.037
Ammonia, aqua, 26°, drums, carboys	lb.	.02¼-.05¼
Ammonium, chloride (sal-ammoniac), white, granular, bbls.	lb.	.05-.075
Sulphate, tech., bbls.	lb.	.035-.05
Sulphocyanide (thiocyanate), pure, crystal, kegs	lb.	.55-.58
Sulphocyanide (thiocyanate), com'l, drums	lb.	.16
Antimony Chloride (butter of antimony), sol., carboys	lb.	.13-.153
Barium Carbonate, ppted., l.c.l., bags, works	lb.	.03
Benzene (Benzol), pure, drums, works	gal.	.21
Butyl Lactate, drums	lb.	.225
Cadmium Oxide, l.c.l., bbls	lb.	.60
Calcium Carbonate (Ppted. chalk), U.S.P.	lb.	.05¾-.075
Carbon Bisulfide, l.c.l., 55 gal. drums	lb.	.05¾-.06
Carbon Tetrachloride, l.c.l., drums	gal.	.73
Chrome, green, commercial, bbls.	lb.	.22
Chromic Sulphate, drums	lb.	.26¼
Cobalt Sulphate, drums	lb.	.59
*Copper, Acetate (verdigris), bbls.	lb.	.25
Carbonate, 53/55%, bbls.	lb.	.14½-.15½
Cyanide, Tech., 100 lb. bbls.	lb.	.34
Sulphate, Tech., crystals, bbls.	lb.	.05
Cream of Tartar (potassium bitartrate), crystals, kegs	lb.	.23¼
Crocus Martis (iron oxide) red, tech., kegs	lb.	.07
Dibutyl Phthalate, l.c.l., drums	lb.	.195
Diethylene Glycol, l.c.l., drums, works	lb.	.155
Dextrine, yellow, kegs	lb.	.05-.08
Emery Flour (Turkish)	lb.	.07
Ethyl Acetate, 85%, l.c.l., drums	lb.	.066
Ethylene Glycol, l.c.l., drums, works	lb.	.17-.20
Flint, powdered	ton	30.00
Fluorspar No. 1 ground, 97-98%.	ton	$60.00
Fusel Oil, refined, drums	lb.	.125-.14
*Gold, Chloride	oz.	$18¼-23
Cyanide, potassium 41%	oz.	$15.45
Cyanide, sodium 46%	oz.	$17.10

*Subject to fluctuations in metal prices.

Gum, Arabic, white, powder, bbls.	lb.	.125-.14
Sandarac, prime, bags	lb.	.50
Hydrogen Peroxide, 100 volume, carboys	lb.	.20
Iron Sulphate (Copperas), bbls.	lb.	.016
Lead, Acetate (Sugar of Lead), bbls.	lb.	.10-.12¾
Oxide (Litharge), bbls.	lb.	.125
Magnesium Sulphate (Epsom Salts), tech., bag	lb.	.018
Mercury Bichloride (Corrosive Sublimate)	lb.	$1.58
Mercuric Oxide, red, powder, drums	lb.	$1.81
Nickel, Carbonate, dry, bbls.	lb.	.36-.41
Chloride, bbls.	lb.	.18-.22
Salts, single, 425 lb. bbls.	lb.	.135-.145
Salts, double, 425 lb. bbls.	lb.	.135-.145
Paraffin	lb.	.05-.06
Phosphorus, red	lb.	.42
yellow	lb.	.55
Potash, Caustic, 88-92%, flake, drums, works	lb.	.07¼-.075
Potassium, Bichromate, crystals, casks	lb.	.09¼
Carbonate (potash) 98-100%, drums	lb.	.06¾
Cyanide, 94-96%, cases	lb.	.525
Pumice, ground, bbls.	lb.	.03
Quartz, powdered	ton	$30.00
Quicksilver (Mercury) 76 lb. flasks	flask	$90.00
Rochelle Salts, crystals, bbls.	lb.	18.25
Rosin, gum, bbls.	lb.	5.25-7.75
*Silver, Chloride, dry, 100 oz. lots	oz.	.31
Cyanide, 100 oz. lots	oz.	.36½
Nitrate, 100 oz. lots	oz.	.27
Sodium Carbonate (soda ash), 58%, bbls.	lb.	.0235
Cyanide 96%, 100 lb. drums	lb.	.15
Hydroxide (caustic soda) 76%, flake	lb.	.0355
Hyposulphite, crystals, bbls.	lb.	.035-.065
Metasilicate, granular, bbls.	lb.	.0315
Nitrate, tech., bbls.	lb.	.029
Phosphate, tribasic, tech., bbls.	lb.	.027
Pyrophosphate, anhydrous, bbls., l.c.l.	lb.	.0595
Sesquisilicate, drums	lb.	.0405
*Stannate, drums	lb.	.32½-.34½
Sulphate (Glauber's Salts), crystals, bbls., works	lb.	.0135
Sulphocyanide, drums	lb.	.30-.35
Sulphur, Flowers, bbls., works	lb.	.037-.0410
*Tin Chloride, 100 lb. kegs	lb.	.37½
Toluene (Toluol), pure, drums, works	gal.	.27
Tripoli, powdered	lb.	.03
Wax, Bees, white, bleached, slabs 500 lbs.	lb.	.35-.37
Bees, yellow, crude	lb.	.21-.215
Carnauba, refined, bags	lb.	.34-.35
Montan, bags	lb.	.115-.12
Spermaceti, blocks	lb.	.23
Whiting, Bolted	lb.	.025-.06
Xylene (Xylol), drums, works	gal.	.31
Zinc, carbonate, bbls.	lb.	.14-.15
Cyanide, 100 lb. kegs	lb.	.33
Chloride, granular, drums	lb.	.06
Sulphate, crystals, bbls.	lb.	.04

Metal prices on page 448.



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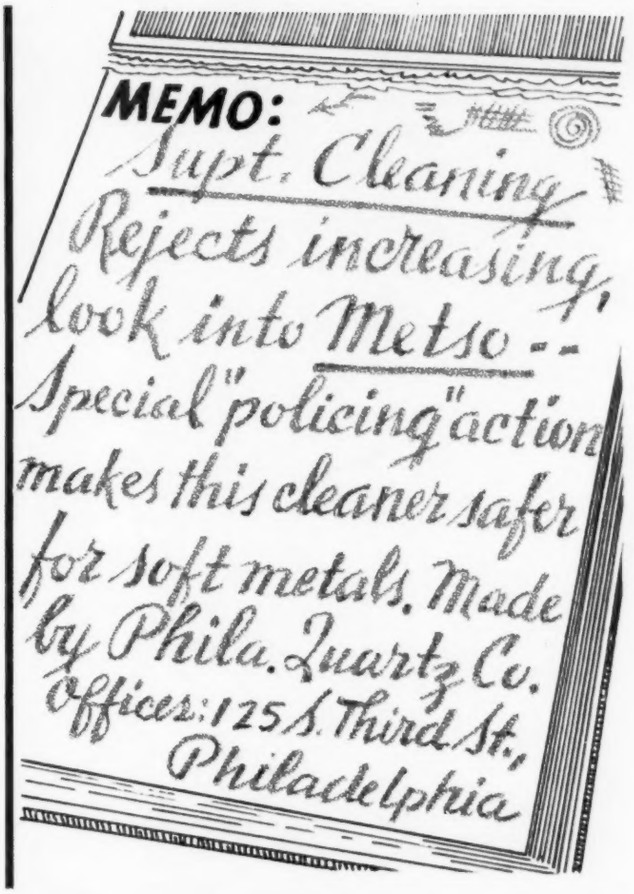

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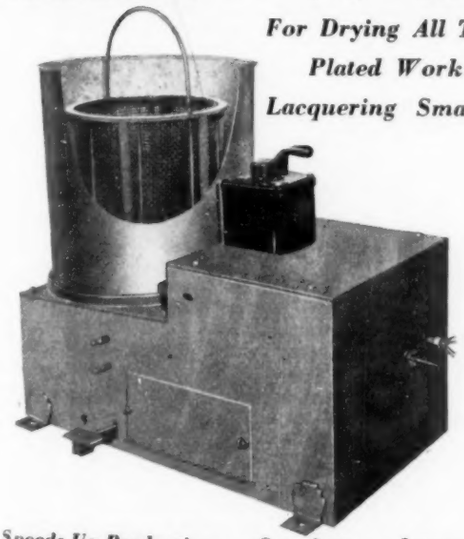

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LIONITE KING OF ABRASIVES NIAGARA FALLS N.Y. GENERAL ABRASIVE CO.

Metal Prices, August 29, 1939

(All quotations are based on wholesale quantities, prompt delivery, New York unless otherwise specified.)

New Metals

Aluminum, Virgin ingot, 99% plus, c.l.	20.00c.
Antimony, Chinese, 99%	14.00c.
Bismuth, Ton lots, American, 99½%	$1.10
Cadmium, Sticks and bars, tons	55c.
Copper, Lake, delivered Conn.	10.50c.
Electrolytic, delivered Conn.	10.50c.
Castings, F.O.B. refinery	10.125c.
Gold, U. S. Treasury price, oz. Troy	$35.00
Lead, Desilvered and Prime Western	5.05c.
Magnesium, 99.95% ingot	30.00c.
Mercury (Quicksilver), Flasks, 75 lb.	$90
Nickel, Ingot or Shot	36.00c.
Electrolytic, 99.95%, sheets	35.00c.
Platinum, oz., Troy	$35-$38
Tin, Straits	49.00c.
Zinc, Prime Western	5.14c.
Brass Special	5.24c.
High Grade	5.75c.
Die Casting Alloy	7.75c.

Ingot Metals and Alloys

	Cents per lb.
No. 1 Yellow Brass	8.75
85-5-5-5	10.75
88-10-2	14.50
80-10-10	12.875
Manganese Bronze (60,000 t. s. min.)	10.75
Aluminum Bronze	15.0
Monel Metal Shot or Block	28
Nickel Silver (12% Ni)	12.75
Nickel Silver (15% Ni)	15.0
No. 12 Aluminum No. 1	13.25-13.50
Manganese Copper, Grade A (30%)	26c
Phosphor Copper, 10%	18.0
Phosphor Copper 15%	19.0
Silicon Copper, 30%	16.0
Phosphor Tin, no guarantee	69.0
Iridium Platinum, 5% (Nominal)	$36.50
Iridium Platinum, 10% (Nominal)	$38.00

Old Metals

Dealers' buying prices, wholesale quantities:	Cents per lb.
Heavy copper and wire, mixed	7.125-7.375
Light copper	6.625
Heavy yellow brass	4.375
Light brass	3.875
No. 1 composition	6.375-6.625
No. 1 composition, turnings	5.625-5.875
Heavy soft lead	4.25-4.40
Old zinc	2.25
New zinc clips	3.25
Aluminum clips (new, soft)	14.00
Scrap aluminum, cast	6.75-7.00
Aluminum borings—turnings	5.50-5.75
No. 1 pewter	30.00-31.00
Electrotype	4.50
Nickel anodes	26.00
Nickel clips, new	27.00
Monel scrap	9.00-13.00

Wrought Metals and Alloys

The following are net BASE PRICES per lb., to which must be added extras for size, shape, quantity, packing, etc., or discounts, as shown in manufacturers' lists. Basic quantities on most rolled or drawn brass and bronze items below are from 2,000 to 5,000 lbs.; on nickel silver, from 1,000 to 2,000 lbs.

Copper Material

Sheet, hot rolled	18.62c.
Bare Wire, soft, less than carload	14.375c.
Seamless Tubing	19.12c.

Nickel Silver

Sheet Metal		Wire and Rod	
10% Nickel	25.50c.	10% Nickel	28.12c.
15% Nickel	26.87c.	15% Nickel	31.37c.
18% Nickel	27.87c.	18% Nickel	34.25c.

Aluminum Sheet and Coil

Base Prices Carload Lots (F.O.B. Mill)

Aluminum Sheet, 20 gauge	35.00c.
Aluminum Coils, 20 gauge	28.00c.

Rolled Nickel Sheet and Rod

Base Prices (F.O.B. Mill)

Cold Drawn Rods	50c.	Standard Cold Rolled	
Hot Rolled Rods	45c.	Sheet	49c.

Monel Metal Sheet and Rod

Base Prices (F.O.B. Mill)

Hot Rolled Rods	35c.	No. 35 Sheets	37c.
Cold Drawn Rods	40c.	Std. Cold Rolled Sheets	39c.

Silver Sheet

Rolled Sterling Silver, 38c. per Troy oz. upward according to quantity.

Brass and Bronze Material

	Yellow Brass	Red Brass 80%	Comm'l. Bronze 90%
Sheet	16.85c.	17.67c.	18.71c
Wire	17.10c.	17.92c.	18.96c.
Rod	12.19c.	17.92c.	18.96c.
Angles, channels, open seam tubing	25.35c.	26.17c.	27.21c.
Seamless tubing	19.60c.	20.32c.	21.11c.

Tobin Bronze and Muntz Metal

Tobin Bronze Rod	18.62c.
Muntz Metal Sheet	20.00c.
Muntz Metal Rod	16.12c.

Zinc and Lead Sheet

Zinc Sheet, carload lots standard sizes and gauges, at mill, less 7% discount	9.75c.
Zinc Sheet, 1200 lb. lots (jobbers' prices)	10.75c.
Zinc Sheet, 100 lb. lots (jobbers' prices)	14.75c.
Full Lead Sheet	8.05c.
Cut Lead Sheet	8.30c.

Block Tin, Pewter and Britannia Sheet

This list applies to either block tin or No. 1 Britannia Metal Sheet, No. 23 B. & S. Gauge, 18 inches wide or less; prices are all f.o.b. mill:

500 lbs. over	15c. above N. Y. pig tin price
100 to 500 lbs.	17c. above N. Y. pig tin price
Up to 100 lbs.	25c. above N. Y. pig tin price

Supply prices on page 446.